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ABSTRACT

This document is the teacher's edition of a module containing 16 instructional units covering competencies for students with career aspirations in horticulture. It is designed to provide high school students with an in-depth perspective of both the technical and the commercial aspects of running a greenhouse. The 16 units cover the following topics: designing and constructing greenhouses; controlling the greenhouse environment; preparing growing media; propagating plants; maintaining plant nutrition; producing a crop; using chemicals in the greenhouse; identifying and controlling pests in the greenhouse; marketing greenhouse products; shipping and receiving greenhouse products; customer relations; performing general office work; maintaining greenhouses; servicing and maintaining equipment; managing the business; and applying safety regulations. Each instructional unit follows a standard format that includes some or all of these 13 basic components: performance objectives, suggested activities, basic academic skills taxonomy, handouts, information sheets, supplements, transparency masters, assignment sheets, assignment sheet answers, job sheets, practical tests, written tests, and written test answers. (KC)

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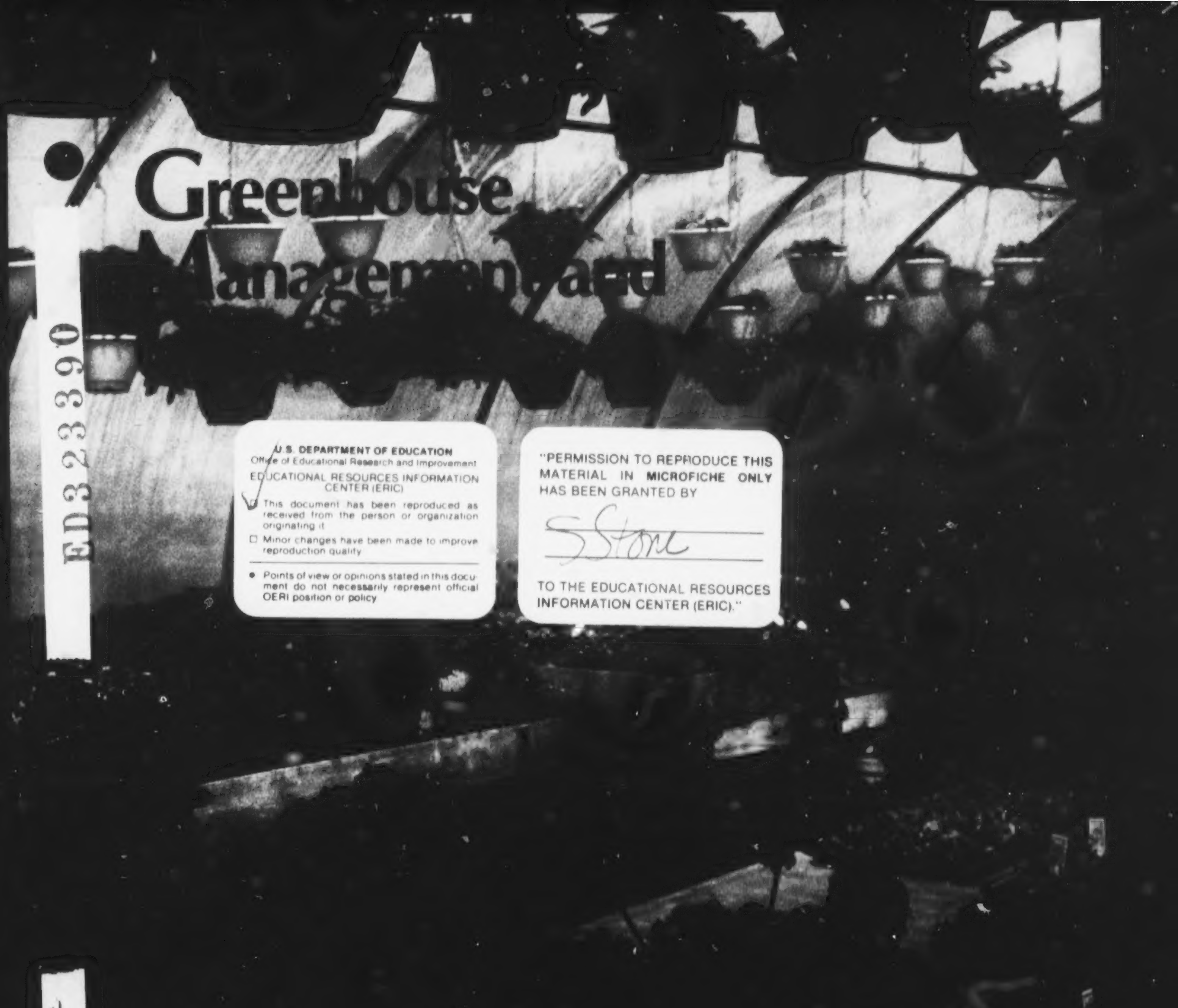

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Teacher Edition

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Greenhouse Management and Operations

Developed by the
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FOREWORD

The Oklahoma Department of Vocational and Technical Education is committed to improving and updating instructional materials to meet the changing needs of agricultural education. Horticulture is one area that is expanding and agricultural education is changing to meet these new needs.

Horticulture is a field that has many opportunities for students who possess the information and skills needed for employment. *Greenhouse Management and Operations* provides students an in-depth perspective of both the technical and commercial aspects of running a greenhouse.

This publication provides valuable competencies for students with career aspirations in horticulture.

Edward A. Smith, State Supervisor
Agricultural Education
Oklahoma Department of Vocational
and Technical Education

PREFACE

Greenhouse Management and Operations is the second in a series of horticultural publications. This publication follows *Introduction to Horticulture.*

For students who enjoy working with plants, horticulture is a field that offers rewarding career opportunities. Many of these opportunities involve working in a greenhouse.

Greenhouse Management and Operations provides students with practical knowledge about greenhouses that will make them better equipped to be successful in the workplace.

Randy Kirk, Curriculum Specialist
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ACKNOWLEDGEMENTS

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USE OF THIS PUBLICATION

INSTRUCTIONAL UNITS

Greenhouse Management and Operations contains sixteen units. Each instructional unit includes some or all of the basic components of a unit of instruction: performance objectives, suggested activities, basic academic skills taxonomy, information sheets, supplements, transparency masters, activity sheets, assignment sheets, assignment sheet answers, job sheets, practical tests, written tests, and written test answers. Practical tests and written tests are included in the instructor edition only, and may be duplicated for classroom use or copies may be purchased in Oklahoma by calling 800-522-5810. Out-of-state instructors may order test packets by calling 800-654-4502.

All of the unit components focus on measurable and observable learning outcomes. Instructors are encouraged to supplement, personalize, localize, and motivate with these materials in order to develop a complete teaching/learning process.

Units of instruction are designed for use in more than one lesson or class period of instruction. Careful study of each unit of instruction by the instructor will help him or her determine the following:

Amount of material that can be covered in a class period

- Skills that must be demonstrated
  - Supplies and equipment needed
  - Amount of class time needed for demonstrations
  - Amount of time needed for student practice
- Supplementary materials, including print and non-print media to be ordered
- Resource people to be contacted

Objective Sheets (White Pages)

Each unit of instruction is based on performance objectives. Performance objectives are stated in two forms: unit objectives, stating the subject matter to be covered in a unit of instruction, and specific objectives, stating the performance necessary to meet the unit objective.

The unit objective states the overall goal of the unit. It tells what the student should be able to do and what standard will be used to determine whether the student has achieved competency. Specific objectives outline the teaching sequence of the competencies required to meet the unit objective.

- The objectives should be provided for students and their importance stressed throughout the teaching/learning process. By doing this, instructors will help answer any questions concerning performance requirements for each instructional unit. Instructors can also use the objectives to plan teaching strategies and instructional methods. Instructors should prepare for each unit by deciding how each objective can best be taught.

Instructors should feel free to modify, delete, or add objectives in order to meet the needs of the students and community. When objectives are added, the instructor should remember to supply the needed information, assignment sheets, job sheets, and criterion test items.

Suggested Activities (Pink Pages)—**Instructor's Edition Only**

The suggested activities component is to assist during the preparation stage of the teaching/learning process. The activities provide suggestions for delivery, application, and evaluation during the instructional process. Teaching suggestions are included for each objective. The instructor should read the suggested activities before teaching the units to allow time to obtain supplemental materials, prepare audiovisual materials, and contact outside resource persons. Duties of the instructor will vary according to the particular unit.

Listed are suggested resources including people and print and non-print media that may be used to teach the unit. Unit references used in the development of each unit are also provided. The instructor can use suggested resources and unit references to supplement his or her knowledge of the subject or to help students with particular interests or objectives in the area covered. Please note that suggested resources and references listed in this publication existed when this publication was written. CIMC assumes no responsibility for providing these materials and cannot ensure the availability of these materials as individual vendors, manufacturers, and publishers may discontinue these products at any time.

Basic Skills (Pink Pages)—**Instructor's Edition Only**

The Basic/Essential Skills Taxonomy, 2nd ed., by Lester M. Snyder, Jr., was used to identify the basic academic skills applied in each objective. *Greenhouse Management and Operations* uses criterion-referenced testing, which identifies cognitive and psychomotor skills, stated as performance objectives, that students are expected to learn. In *Greenhouse Management and Operations*, all of the cognitive and psychomotor skills also require student to use academic skills. *The Basic/Essential Skills Taxonomy* provides a means for identifying academic skills students use in meeting the performance objectives.

Information Sheets (Green Pages)

The information sheets provide "must know" content that is essential for meeting the cognitive objectives. The information sheets serve as an excellent guide for presenting background knowledge necessary to develop the skills specified in the unit objective. They may also be used for coordination activities and advisory committee meetings.

Students should read the information sheets before the information is discussed in class. Space is provided in margins for students and instructors to add notes that supplement, localize, personalize, or provide motivation for each unit.

The information sheets may include notes, cautions, or warnings. These should be discussed carefully and thoroughly. Notes are short verbal additions to the information or procedural outline that provide nice-to-know and decision-making information. A note may tell the student what to look for or consider at a given step, or may explain when a step may not be applicable. Notes offer guidance that may help the student understand the process and accomplish it more efficiently. Warnings are advisories that alert the student to possible danger to himself or herself or others. Cautions are advisories that alert the student to possible danger to equipment or facilities.

Supplements (Green Pages)

Supplements are in the instructor and student material. Supplements include instructions that could be used for solving problems or reinforcing the enrichment of learning. The information presented in a supplement may consist of tables, charts, written information, forms, or other information students will need in order to complete one or more of the assignments or job sheets. While supplements are not tested over directly, they may be used to assist in meeting the performance objectives.

Transparency Masters (White Pages)

With transparency masters, the students may see as well as hear about the material being presented, thus reinforcing the learning process. Transparencies may present new information or they may reinforce information presented in the information sheets or assignment sheets.

Transparencies should be made and placed in the instructor's notebook, where they will be immediately available for use. Transparencies direct the class's attention to the topic of discussion. Transparencies should be left on the screen only when topics shown are being discussed.

Activity Sheets (Tan Pages)

The purpose of activity sheets is to provide activities which support several objectives. Activity sheets vary greatly in their number and design from unit to unit. Some activity sheets deal with the student's attitudes and beliefs. These may ask rather personal questions and are only intended for each students' personal use. Some activity sheets may require the student to monitor his or her own actions or other personal variables over a period of time. Answer sheets may or may not be included.

Assignment Sheets (Tan Pages)

Assignment sheets are written exercises that have students apply higher order thinking skills. The introduction to the assignment sheet explains how the assignment relates to the subject area and unit objective and may provide instructional information or refer students to another component for such information.

Often, assignment sheets will contain case studies, story problems, or other situations in which the student must analyze the circumstances and determine correct responses. Students may be given assignment sheets as classwork or homework.

Assignment Sheet Answers (Pink Pages)—**Instructor's Edition Only**

This component is designed to assist the instructor in evaluating student performance on assignment sheets.

Job Sheets (Blue Pages)

Job sheets provide a list of equipment, tools, and materials needed to complete a manipulative or psychomotor skill. They describe a step-by-step procedure to complete each task or job. Diagrams, photographs, and illustrations assist students in achieving the skill.

The instructor should demonstrate the procedures outlined in each job sheet. Furthermore, the instructor needs to localize the procedure according to the equipment and supplies available in the local situation. Job sheets also show potential employers what skills the student has been exposed to and the performances one might reasonably expect from a student who has had this vocational instruction.

Practical Tests (Yellow Pages)—**Instructor's Edition Only**

The practical tests assist the instructor in evaluating the psychomotor activities (Job Sheets). The practical tests provide instructors with a valid mechanism for determining a student's level of ability to perform the procedure stated on the job sheet and provide the instructor with a means of evaluating the students' final product.

Written Tests (Yellow Pages)—**Instructor's Edition Only**

This component provides criterion-referenced evaluation of every objective listed in the unit of instruction. All performance objectives, including those in the information sheets, assignment sheets, and job sheets must be evaluated. If objectives have been added, deleted, or modified, appropriate changes should be made on the test.

The tests may be written or oral. It is recommended that the tests be divided into shorter tests covering three or four objectives at a time and given soon after those objectives have been covered.

The acceptable response on a written test, eighty-five (85) percent in most units, may be raised or lowered to fit the topic or student ability level. The percentage applies to the overall score, not to each individual question. The final unit grade should be obtained by combining written test and assignment sheet scores, and by considering how well the student demonstrated the desired skills.

Written Test Answers (Pink Pages)—**Instructor's Edition Only**

This component is designed to assist the instructor in evaluating student performance on written tests.

PAGE NUMBERING

Each publication for the CIMC is assigned a specific abbreviation or will be recognized by the book title. *Greenhouse Management and Operations* will be referred to by title. Each unit is identified by the unit number in Roman numerals. Each unit in the publication begins with page 1. The page number for an objective sheet in *Greenhouse Management and Operations* looks like the following:

OBJECTIVE SHEET - Greenhouse Management
I - 1

METHODS OF DISSEMINATING MATERIAL

Each student should be provided with student materials. Materials may be purchased for less than an instructor can reproduce them, especially when the instructor's time is considered. Student materials contain everything but the suggested activities, handouts, assignment sheet answers, tests, and test answers. Written test packets may be purchased from the Curriculum and Instructional Materials Center. The student should be allowed to take his or her materials home at the end of the year.

TEACHING METHODS

It is a challenge to keep students motivated. Instructors can supplement the objectives by providing the "why," personal experiences, and current information. Preparation for each unit should be determined by how each objective can best be taught. Students should become involved in preparing and planning for each unit.

COMPETENCY PROFILES

A competency profile is available for each CIMC publication. Competency profiles document student performance. The profile contains a list of the specific competencies that a student should achieve before leaving the training program. Profiles should be distributed to students as needed.

CORRECTIONS AND SUGGESTIONS

The Curriculum and Instructional Materials Center (CIMC) wants to provide vocational instructors and students with materials that are accurate and effective. Although the CIMC strives to maintain the highest standards of development and production, oversights occasionally do occur. If you find any errors in this or other CIMC publications, or have suggestions for improving their usefulness in vocational programs, please notify the CIMC staff. One easy way of pointing out errors is to make a photocopy of the affected page and to indicate the correction on the copy. Mail this information to the CIMC, where it will be used to correct the publication before the materials are reprinted.

To ensure that the material is updated on a timely basis, notify the CIMC of necessary corrections as soon as possible after discovering the error. Do not assume that someone else will notice the error and inform the CIMC; other users may be making the same assumption. Please send corrections and recommendations for improving this publication to the following address:

Curriculum Development Coordinator
Curriculum and Instructional Materials Center
Oklahoma Department of Vocational and Technical Education
1500 West Seventh Avenue
Stillwater, Oklahoma 74074-4364

OBJECTIVE SHEET

DESIGNING AND CONSTRUCTING GREENHOUSES

I

INTRODUCTION

Having your own greenhouse business can be a rewarding career. A greenhouse is considered a long-term investment and usually requires a large amount of capital. Because of these factors it is important to have a detailed plan for construction so your success will be ensured.

UNIT OBJECTIVE

After completing this unit, the student should be familiar with the basic types of greenhouse structures and understand the factors associated with proper greenhouse location and construction. The student will demonstrate these competencies by completing an assignment sheet and written test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with greenhouses and greenhouse construction to their correct definitions.
2. List factors to be considered before building a greenhouse.
3. List legal and building requirements for greenhouse construction.
4. Match the different types of greenhouse designs to their correct illustrations.
5. Describe the different types of flooring used in greenhouses.
6. Select from a list true statements concerning heating and cooling systems.
7. Select from a list true statements concerning drainage.
8. Select from a list true statements concerning bench types, materials and layout.
9. Discuss backup emergency systems.
10. List energy saving measures for greenhouses.
11. Discuss cold frames and hot beds.
12. Calculate building cost on a per square foot basis. (Assignment Sheet 1)

SUGGESTED ACTIVITIES

DESIGNING AND CONSTRUCTING GREENHOUSES

I

PREPARATION

- Obtain materials to supplement unit.

  NOTE: See Suggested Resources.

- Review instructional outline for this unit. Modify time frames to suit class needs and plan activities for each class period.
- Study the specific objectives to determine those you will cover in your presentation. Decide also which objectives should be taught to which students.
- Determine scope and sequence of objectives that you add. Design and develop support materials, including evaluation techniques, for additional objectives.
- Determine how you will schedule time for students to demonstrate competence in the required procedures.
- Make arrangements for guest speakers. Supply speakers with specific objectives and other appropriate sections of the unit.
- Make arrangements to tour local greenhouses.
- Assemble a slide set showing different types of greenhouses.
- Collect samples of different greenhouse covering materials and building components from manufacturers.

DELIVERY

Objective 1

- Introduce the topic of designing and constructing greenhouses.
- Show slides of various greenhouse styles.
- Discuss terms associated with greenhouses and greenhouse construction.

Objective 2

- Discuss with students factors to be considered before building a greenhouse. Ask students which factors they consider most important.

- Select a local greenhouse and discuss with students the factors which might have been considered before its construction and how they think the factors relate to the greenhouse.

Objective 3

- Discuss legal and building requirements for greenhouse construction.

- Invite a local building inspector to discuss required building permits and various inspections that must be completed.

Objective 4

- Discuss the different greenhouse designs. Have students discuss the advantages and disadvantages of each design and which style they prefer.

- Discuss the importance of planning all steps of greenhouse construction.

Objective 5

- Discuss types of flooring, and the advantages and disadvantages of each.

Objective 6

- Discuss heating and cooling systems for greenhouses.

- Arrange a tour of local greenhouses so students can observe different styles of greenhouses and various covering materials. Also, make the students aware of each operation's method of heating and cooling.

- Arrange to visit some local hobby greenhouses. Have students discuss the similarities and differences between hobby and commercial greenhouses.

Objective 7

- Discuss drainage for greenhouses.

Objective 8

- Discuss bench types, materials and layout.

- Have students design their own bench type and layout for a greenhouse.

Objectives 9 and 10

- Discuss backup emergency systems. Ask students what types of emergency problems are most likely to occur in your area.
- Discuss energy saving devices.
- Have students analyze the school greenhouse for backup emergency systems and energy saving devices.

Objective 11

- Discuss cold frames and hot beds.
- Construct a cold frame or hot bed and grow a cool season crop.

APPLICATION

Objective 12

- Use Assignment Sheet 1 to give students practice in calculating the cost of greenhouse construction.

EVALUATION

Written Test

- Explain to students that they will be asked to demonstrate on the written test actions listed in the specific objectives.
- Give written test

  NOTE: The written test may be given in sections if desired.
- Evaluate students on assignment sheet activity if not previously done.
- Reteach and retest if necessary.
- Complete appropriate section of competency profiles.
- Review individual and group performance in order to evaluate teaching methods. Adjust scope, sequence, or instructional approaches for additional lessons as required.

SUGGESTED RESOURCES

Audiovisual Materials

- *Building a Greenhouse*

  NOTE: This video is available from the Curriculum and Instructional Materials Center, Oklahoma Department of Vocational and Technical Education, 1500 West Seventh Avenue, Stillwater, OK 74074. Oklahoma instructors may order by calling 1-800-522-5810 ext. 589. Out-of-state instructors call 1-800-654-4502. 1/2" VHS. Price $10.

Publications

- *Greenhouse Grower Magazine*, Meister Publishing Co., 37841 Euclid Ave., Willoughby, OH 44094.

UNIT REFERENCES

- Ball, Vic, *Ball Red Book*, Reston Publishing Co., Reston, Virginia, 1985.
- Nelson, Paul V., *Greenhouse Operation and Management*, 3rd ed., Reston Publishing Co., Reston, Virginia, 1985.

BASIC ACADEMIC SKILLS

The following table identifies the basic academic skills that are reinforced in this unit of instruction. These basic academic skills were identified using ***The Basic/Essential Skills Taxonomy***, 2nd edition, and verified during the validation process.

	SKILL AREA/ CODE	**VERB**	**LINK A**	**LINK B**
OBJECTIVE 1	Language Arts 013	Applies/Uses	Definitions	
	Science 466	Identifies	Definitions	
	Science 476	Identifies	Matter	Uses
OBJECTIVE 2	Language Arts 132	Comprehends	Information-written	
	Language Arts 038	Collects/ Organizes	Information-oral/written	
OBJECTIVE 3	Language Arts 132	Comprehends	Information-written	
	Language Arts 038	Collects/ Organizes	Information-oral/written	
OBJECTIVE 4	Language Arts 013	Applies/Uses	Definitions	
	Science 466	Identifies	Definitions	
	Science 476	Identifies	Matter	Uses

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 5	Science 342	Describes/ Explains	Matter	Properties
	Science 343	Describes/ Explains	Matter	Structure
	Science 344	Describes/ Explains	Matter	Substance
	Science 345	Describes/ Explains	Matter	Uses
OBJECTIVE 6	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity
OBJECTIVE 7	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity
OBJECTIVE 8	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity
	Science 474	Identifies	Matter	Physical properties

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 9	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
	Science 273	Describes/ Explains	Heat	
	Science 281	Describes/ Explains	Heat	Insulation
	Mathematics 229	Solves problems	Generate conclusions	Deductive reasoning
OBJECTIVE 10	Language Arts 132	Comprehends	Information-written	
	Language Arts 038	Collects/ Organizes	Information-oral/written	
	Science 281	Describes/ Explains	Heat	Insulation
OBJECTIVE 11	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
	Science 342	Describes/ Explains	Matter	Properties
	Science 343	Describes/ Explains	Matter	Structure
	Science 273	Describes/ Explains	Heat	

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	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 12	Mathematics 034	Computes	Addition	Whole numbers
	Mathematics 073	Computes	Multiplication	Whole numbers
	Mathematics 047	Computes	Division	Whole numbers
	OR			
	Mathematics 261	Uses calculator	Addition	
	Mathematics 262	Uses calculator	Division	
	Mathematics 266	Uses calculator	Multiplication	

INFORMATION SHEET

DESIGNING AND CONSTRUCTING GREENHOUSES

I

OBJECTIVE 1

Match terms associated with greenhouses and greenhouse construction to their correct definitions.

- **Acrylic**--A transparent double layer material used as a greenhouse covering; it is rigid, flammable and has moderate resistance to breakage

  NOTE: This material shrinks and swells with temperature changes and requires special installation procedures.

- **Bows**—Semicircular shaped pieces of metal that form the frame of a quonset greenhouse

- **Fiberglass**—A semi-rigid covering material made by embedding strands of fiber in a plastic resin

  NOTE: These sheets of greenhouse covering material may be flat or corrugated, are very durable and may be bent, cut, or nailed. Probably the least expensive greenhouse covering in the long run. Fiberglass is flammable.

- **Free standing greenhouse**—A single greenhouse not attached to any other greenhouse

- **Glass**—A greenhouse covering that has the highest light transmission; comes in rigid panels that are especially made for greenhouses; has the longest life expectancy and high maintenance requirements

  NOTE: It is seldom used today because of cost.

- **Greenhouse**—A structure covered with a light transmitting material; the environment is controlled for the purpose of producing plants

- **Greenhouse range**—A group of greenhouses in the same area

  NOTE: It may be a free standing or gutter connected range.

- **Gutter connected greenhouse**—A greenhouse that is attached to other greenhouses at the gutter

- **Poly lock**—A system of securing polyethylene coverings on a greenhouse

  NOTE: One half of the poly lock is permanently attached to the stem wall and the other half is snapped on the mounted half. A piece of polyethylene is draped over the poly lock on the stem wall and the remaining half of the poly lock is snapped on. The polyethylene is tightly secured the entire length of the greenhouse. Poly lock is durable and may be reused year after year.

- **Polycarbonate**—A rigid greenhouse covering that is made of double layers, has high light transmission, is flame retardant and has the strongest resistance to breakage

  NOTE: This material may be bent, cut, drilled or nailed and does not require special installation.

- **Polyethylene**—A flexible film that is used as a greenhouse covering

  NOTE: Polyethylene, often called poly, is the most common greenhouse covering material due to the low initial cost. It is expensive over the long term due to frequent replacement. It is easy to apply, has excellent heat retention, has little resistance to force, is flammable and is degraded by ultraviolet light.

- **Purlins**—A framing member which runs the length of a greenhouse roof and holds the bows and trusses upright

- **Stem wall**—A short rigid wall that is the foundation of a greenhouse and where the covering is attached; usually composed of concrete, cinder blocks, or wood

- **Structural material**—The components used as a greenhouse frame

  - **Wood**—Very good for hobby greenhouses or small custom designed houses: has a low initial cost but requires large amounts of maintenance and painting

    NOTE: The use of pressure treated chromated copper arsenate lumber is recommended. Never use wood treated with creosote or penta chlorophenal; it releases toxic fumes.

  - **Galvanized metal**—Most commonly used structural material. Due to a coating on the material, very little maintenance is needed and the frames are strong and long lasting. The cost is higher initially but is cheaper in the long run. Most greenhouse kits come with galvanized metal frames that are predrilled and ready for assembly.

- **Truss**—An interconnecting group of framing members that form the roof in a ridge and peak greenhouse

OBJECTIVE 2

List factors to be considered before building a greenhouse.

A greenhouse should be considered a permanent structure since moving it requires a large amount of time and money. For this reason it is important to obtain as many facts as possible before you build. Listed below are factors that should be considered.

- **Accessibility**

  EXAMPLE: Is this location close to your intended customers, and is it easy for them to find? Are the roads in good condition and will they be usable 12 months of the year?

- **Expandability**

  EXAMPLE: Does this location provide room for the operation to expand in a year or five years? Is there room for parking now and in the future?

- **Markets**

  EXAMPLE: Will your greenhouse be near your intended markets? Will customers have to drive unrealistic distances to your business? Is this location convenient to shipping sources? Will you be able to receive supplies easily?

- **Orientation**

  NOTE: A free standing greenhouse located above 40 degrees North latitude should be built so the greenhouse runs east to west. A greenhouse built below the 40 degree North latitude should run north to south. The 40 degrees North latitude is roughly a line from Philadelphia to Denver to Sacramento. It is recommended that gutter connected ranges run in a north-south orientation regardless of the latitude.

- **Personnel**

  EXAMPLE: Is there a source of labor at this location? Would employees want to move to this location with their families?

- **Topography**

  NOTE: Land should be level with few trees or existing structures. Buildings and trees cast unwanted shadows on the greenhouse.

- **Utilities**

  EXAMPLE: Are electricity, natural gas and phone services available? Are these services reliable? Will you be considered a commercial user?

- **Water**

  NOTE: Water is the most important factor but often the least considered. The water must be available in abundant supply and of good quality. Have a sample sent to a laboratory for standard analysis, salt content, bicarbonate levels and pH.

OBJECTIVE 3 **List legal and building requirements for greenhouse construction.**

The required permits will vary according to each city, town, or county. Check with your local community or county courthouse for information on permits, zoning and builder covenants.

- **Zoning restrictions**

  NOTE: Determine if the property where you want to build is zoned for commercial business.

- **Building permits**

  NOTE: Usually a form must be filed with local authorities stating what is being constructed, and a building permit must be purchased. The granting agency will inform you of restrictions and may require that you meet building code standards.

- **Inspections**

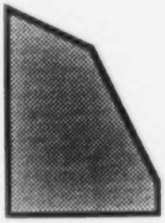
  NOTE: Generally, electrical wiring and plumbing must be inspected by licensed inspectors before construction can proceed. Local officials will inform you of the proper procedure for your location.

OBJECTIVE 4

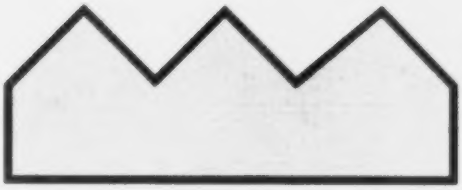
Match the different types of greenhouse designs to their correct illustrations.

There are several commonly used styles of greenhouses and you as the owner can choose which one will fit your situation. You also have some flexibility as to how you will arrange the interior of your greenhouse.

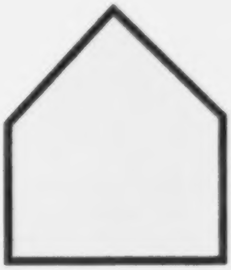
- **Lean-to**—A greenhouse that is attached to an existing structure, usually a house, on the south or west side. The greenhouse has only one side wall because the existing structure provides the other side wall. It is usually covered by some type of rigid greenhouse covering. It is typically a hobby greenhouse that has limited commercial use.



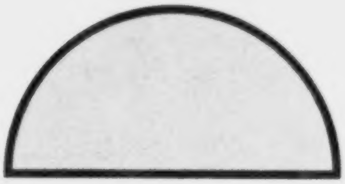
- **Ridge and furrow**—A name for a greenhouse range that is made of gutter connected ridge and peak greenhouses.



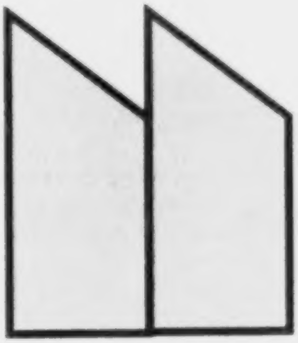
- **Ridge and peak**—A greenhouse that has a pitched roof and forms a ridge at the peak of the roof. A classic greenhouse design that is covered with one of the rigid greenhouse coverings. Sometimes called an even span greenhouse.



- **Quonset**—A greenhouse composed of arch shaped bows placed in a row. This greenhouse appears tube shaped and usually has a low profile. It is the most common style of greenhouse and may be covered with polyethylene or a rigid type material.



- **Sawtooth**—A greenhouse that has a vent near the eave of the lowest side wall that allows the house to be cooled by natural ventilation. This design is common in the southern U.S. where snow loads are light.



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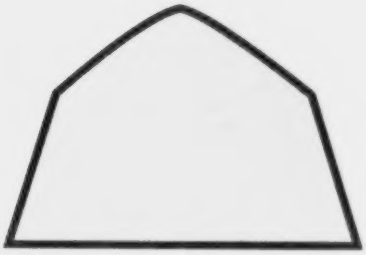
- **Gothic**—Slightly pointed greenhouse covered with corrugated fiberglass.



OBJECTIVE 5

Describe the different types of flooring used in greenhouses.

- **Bark**—A nonpermanent flooring material that is expensive in the long run. Initially attractive but soon decomposes or is compressed into the soil below. Difficult to move carts or equipment, cannot be cleaned or pasteurized, and harbors weeds and insects.

- **Concrete**—A permanent flooring that is expensive initially but inexpensive in the long run. Is easy to clean and pasteurize, and allows the use of carts and machinery.

- **Gravel**—A nonpermanent flooring that is commonly used. It does not allow the easy use of carts or equipment, it harbors weeds, insects and diseases and will eventually become embedded in the soil below.

- **Mixed flooring**—Floors that are made of two different materials used in specialized areas for specific reasons. Many greenhouses have concrete aisles with gravel under the benches. The concrete is used for customer safety and movement of equipment within the house. The gravel covers the soil and gives a neat looking appearance.
- **Soil**—The worst choice of flooring. A grower has decided not to put down any floor material and simply walks on the soil. This type of floor is a hazard to your employees and customers due to the slippery nature of soil. Weeds and insects can become severe problems. Foliar diseases may appear on your crops due to high humidity.

OBJECTIVE 6

Select from a list true statements concerning heating and cooling systems.

The method of heating and cooling a greenhouse will depend on the intended use and the availability of utilities. If only bedding plants are to be sold in the spring, there is no need to install a summer ventilation system. If you are planning on growing all year long a heating and cooling system will be required.

There are many ways to heat a greenhouse, but not every method is safe, reliable or easy to use. Some people heat with wood burning stoves, but not many people will stay up all night to keep a wood stove burning. Listed below are the most common methods of heating.

- **Unit heaters**—(also call forced-air heaters) These heaters have three major parts: a combustion chamber, a heat exchanger, and a blower. All of the parts are enclosed in one unit and can be independently replaced or repaired. The grower has the option of locating the heater wherever he or she chooses. Natural gas or propane are required to operate this heater and electricity is needed for the blower to operate. Heaters are available in different sizes and energy efficiency ratings. This is the most common method of heating.

- **Hot water heat**—This method uses recirculated water that is heated to 180-190° F and then pumped through a system of tubes or pipes. As the water circulates through these tubes it gives up heat and the greenhouse environment is warmed. The grower has the option of running tubes along the greenhouse walls, in the floor, or on the benches. If the heat is put on the bench, rubber tubes are used. If the heat is placed along the walls, aluminum fin radiators are usually used. Small scale boilers are good for heating the water. There are also European type tankless water heaters on the market and they have been used with success. Generally, typical U.S. water heaters will not work because they heat too slowly. With the boiler system, several greenhouses can be heated with one unit. Boiler systems do require maintenance and are initially expensive. Tankless water heaters are less expensive, require less maintenance, but are not as long lived as a boiler. Tankless heaters do provide the grower with some protection since the entire range is not heated with the same heat source. If the boiler breaks down there is no heat in any of the greenhouses. If a tankless heater goes down only that greenhouse has no heat. Natural gas or propane are the best fuels for boilers, but coal, oil or wood will also work.

- **Root zone heat**—A unique name for hot water heating that places rubber tubes on the bench in intimate contact with the root zone of the plant. This is an economical method because only the area near the plant is heated and not the entire greenhouse environment.

- **Steam heat**—This system works on the same principle as hot water heat only steam is circulated through the pipes. These pipes may only be placed along the walls or floors and not directly on the bench. Water must be heated to 212-215° F to produce steam and the steam is then circulated through the greenhouse. Heat is released and the steam condenses to water and is then reheated. This method of heating requires large boilers and someone who is knowledgeable of their operation. Very few greenhouse operations find steam heating an economical method.

- **Infra-red heating**—This method of heating warms solid objects like plants, employees and benches but the air is not heated and remains cool. This system of heating was originally predicted to be very energy efficient since the entire greenhouse environment is not heated. These heaters are expensive, require a lot of maintenance and are short lived, so they have not gained widespread use.

- **Solar heating**—A heating system that traps the sun's radiant energy in water filled solar collectors. This heat is released into the greenhouse by running the hot water through tubes in the greenhouse. This system is basically a hot water heating system that uses the sun as the heat source. Unfortunately, solar energy technology has never been completely developed. There are a few greenhouses that use solar heat for a portion of their heating needs but it is not a total heating system.

  The heating methods above represent the basic heating systems a greenhouse grower can choose. Regardless of the method there are a few rules you should follow.

  - Always vent the exhaust from your heater. If the combustion process is not complete, carbon monoxide and/or ethylene will be released into your greenhouse and plant growth problems will occur. The exhaust stack should be at least 8 inches above the highest point of the roof to insure adequate venting. If a power vent is used this rule can be ignored. A power vent is an exhaust stack that has a fan built in to force the exhaust outside.

  - Use some method to stir the air inside the greenhouse while heating. Most growers use a fan jet system. This is a fan that has a perforated plastic tube attached to it running the length of the greenhouse. The warmed air is pulled into the fan, blown through the tube, and mixed evenly throughout the greenhouse. The fan jet is usually mounted near the heater so the warm air can be drawn in and evenly circulated in the greenhouse. One of the newer systems uses several fans but does not use the perforated plastic tube.

Plants do not grow well if temperatures are too hot or too cold, so cooling a greenhouse is just as important as heating. The only way to cool a greenhouse is to fill it with cool air from outdoors. But, if the outdoor temperature is 90° F there won't be much of a cooling effect. Greenhouse growers have learned that if water is evaporated from a surface the air temperature is lowered. Because of this the evaporative cooling system was developed and is the most widely used cooling system in greenhouses.

- **Evaporative cooling**—(also called fan and pad cooling) The most commonly used system in the greenhouse industry. This system uses a pad that absorbs water and exhaust fans to pull air through the pad and greenhouse. This pad must be capable of absorbing water, drying out and then rewetting. Originally, the pad was composed of aspen or shredded wood, but this material only lasted one season. Today pads are composed of treated paper that lasts several years. Pads are installed so that water is dripped on top of the pad and the entire pad system stays wet. The exhaust fans, located on the opposite end of the greenhouse, are controlled by a thermostat. When the interior of the greenhouse becomes too hot the thermostat causes the cooling system to begin operating. The vent door opens, water begins to drip on the pad and the exhaust fans come on. Air is pulled through the pads and exits through the fans. The air that comes through the pads is cooled by evaporation and replaces the hot air in the greenhouse. The greenhouse remains cool because the fans run continuously and pull newly cooled air inside. Evaporative cooling works well in areas where the outside humidity levels are low. When the outside humidity levels become high evaporative cooling is not as efficient.

- **Natural cooling**—A system that replaces the air inside a greenhouse with outside air. The outside air may be pulled in by a fan, or by natural breezes. This method of cooling is only effective in the early spring when the outside air is cool or in climates where the summer temperatures remain low.

- **Fog cooling**—A newer modification of the fan and pad system in which pads are eliminated. Fog nozzles are installed throughout the interior of a greenhouse and emit a fog. As the fans pull outside air in, the fog evaporates and the air temperature is lowered. Since the fans are constantly running, cool air is being pulled through the greenhouse and the temperature is lowered.

- **Shading**—Applying shade reduces the interior air temperature a few degrees but will not cool the greenhouse. This treatment also lowers the light intensity and should not be considered as a cooling system.

OBJECTIVE 7

Select from a list true statements concerning drainage.

Producing greenhouse crops requires large volumes of water. A portion of this water is not consumed by plants and ends up as waste water that must be carried away. There are two drainage questions that need to be dealt with when developing a construction plan.

- **Where is the water inside the greenhouse going to go?** If the floor is gravel, bark or soil it will quickly become saturated and the greenhouse will have standing water. With this type of flooring you will need to install drain tiles and direct the water out of the greenhouse. This is done by digging several trenches 10-12 inches deep and placing plastic perforated drain pipe in the bottom of the trench. Cover the drain pipe with 4-6 inches of gravel and fill the remaining trench with soil. Make sure that the drain pipe slopes 1 inch for every 10 feet in length; this guarantees that the water will move the length of the greenhouse and drain outdoors.

  If the greenhouse has concrete floors you must decide how many drains you want, and where they will be located. It is best to have at least one drain located at each end of the greenhouse. Some growers prefer to have the drains in the center of the house while others prefer them near the sidewalls. Whatever the location make sure the floor slopes toward the drains. It is very frustrating when water stands on concrete floors because a slope was omitted or was placed in the wrong direction.

- **Where is the water going once it gets outdoors?** Ground level outside a greenhouse should be graded so that all excess water drains away from the greenhouse structure and towards the desired drainage area. A greenhouse operator is responsible for the direction and control of waste water from his or her business. Home owners or businesses next door will not appreciate their property being flooded by drainage water. If you are in an urban location the local sewage disposal system will probably be used. The city may restrict what types of materials are discharged, and using the system can be expensive. However, if the business is in a rural location a water drainage plan will have to be developed. The amount of water that is discharged from your operation will determine if a septic tank or sewage lagoon will be used.

OBJECTIVE 8

Select from a list true statements concerning bench types, materials and layout.

There are many bench types routinely used in greenhouses. Some are commercially available and many more are designed by innovative growers to fit their own special needs. The most commonly used types are:

- **Raised benches**—These benches are raised off of the floor, generally 24 to 36 inches. This is a convenient working height for employees and a comfortable shopping level for customers. The grower has the option of adjusting the height to suit his or her plan.

- **Ground beds**—These are benches that are constructed directly on the floor and filled with media. These beds are usually 6-8 inches deep and the crop is grown directly in the media, This bench type is mainly used for cut flower production, and only a few growers still use this system today.

- **Movable benches**—(also called rolling benches) This is a specially designed raised bench that is made to roll sideways. The legs and frame of the bench are stationary but the bench top slides left and right. These benches were introduced in the mid 1980's and are gaining popularity because they eliminate the need for several aisles in the greenhouse. Movable benches are the most space efficient. With these benches the grower only needs to leave one aisle open for worker access. If the employee needs to get to the middle of the greenhouse, they simply slide the benches over until the walkway is in the desired location. Rolling benches are commercially available in galvanized metal and are generally built to run the length of the greenhouse.

- **Ebb and flow benches**—Another type of raised bench that is approximately 3-6 inches deep and capable of holding water. The growing containers are placed on the bench as usual and when the crop needs irrigation the bench is flooded with water. The pots sit in this 3-6 inches of water and absorb moisture by capillarity. When the pots have been thoroughly watered, the plug is removed and the water drains from the bench into a storage tank. These benches are becoming very important in areas of the country where waste water must be reduced. Ebb and flow benches are commercially available and some manufactures produce rolling ebb and flow benches.

- **No benches**—Some of people grow bedding plants directly on the greenhouse floor; however, few potted plants are grown there. This is an unsanitary method that causes disease problems and poor plant growth. The grower places the pots and flats in groups on the floor as if they were on a bench. This can create unpleasant working conditions for employees and is unappealing to the customer.

Greenhouse bench construction is limited only by the imagination. A grower interested in the rolling or ebb and flow systems will generally purchase them. There are other pre-made benches commercially available but many growers choose to construct their own. Some of the materials commonly used in bench construction are listed below.

- **Concrete blocks**—Universally used as the legs of any raised bench. They are durable, inexpensive and can be easily moved and reassembled.

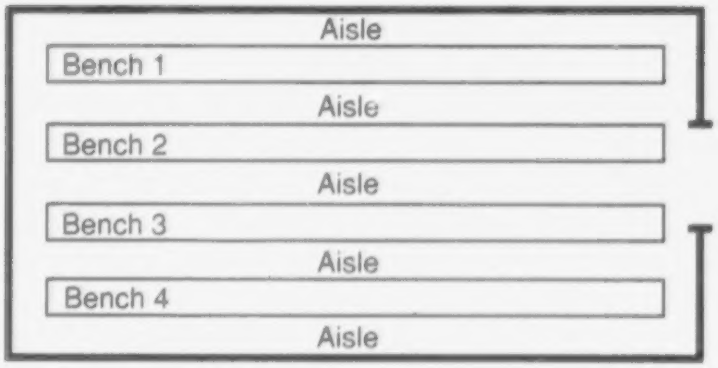
- **Wood**—Probably the most common component. Cheap and easy to work with. A frame is constructed and then some type of small mesh wire is nailed on top. Chromated Copper Arsenate (CCA) treated wood should be used; this is often referred to as 40 year lumber.

- **Redwood lath**—This can be rolled out over concrete blocks and used as a lightweight bench.

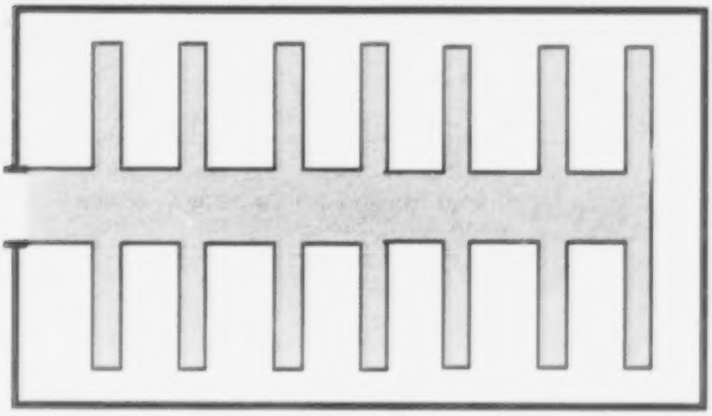
- **Wooden pallets**—These provide very strong bench tops and can usually be obtained free of charge.

The benches in a greenhouse are usually arranged in one of the following basic patterns.

- **Parallel benching**—Benches run the length of the greenhouse and have several aisles. This method is not space efficient.



- **Peninsular benching**—This bench arrangement has one major aisle in the center of the greenhouse. Other short aisles run perpendicular to the center aisle. This arrangement is more space efficient than parallel benching.



OBJECTIVE 9

Discuss backup emergency systems.

The production of plants in a greenhouse is risky when you consider all the things that could go wrong. What happens if there is a sudden loss of electricity and the outside temperature is 95° F, or it's 35° F outside and one of your customers accidentally backs their car into the greenhouse and tears the poly? No one can predict when an emergency will occur, but a good greenhouse grower will be ready. What happens if it's 2 a.m. and the heat goes out in the greenhouse? How would the grower know it? If there was a temperature sensing alarm system it would call and alert the grower to the problem. For this reason all greenhouses should have an alarm system connected to the phone. The greenhouse operator should also keep extra supplies on hand and have some type of emergency backup plan prepared. Below are a few of the emergencies a grower should be ready to handle.

- **Loss of heat**—When heat is lost in a greenhouse the temperature drops rapidly. Within a couple of hours the temperature in the greenhouse could equal the outside temperature. A portable oil or kerosene heater should be on hand and in working order. The Salamander heater has been the traditional backup heater for the greenhouse industry. These heaters emit an exhaust and the ridge vent should be cracked to let the fumes escape.

- **Loss of electricity**—This can be disastrous in the summer because fan and pad systems will not function. The temperature in the greenhouse can rise 20° F or more in a very short time without cooling. If you have a generator it can be used to run the fans. They usually don't produce enough power to run all electrical equipment, but should be able to run some of the exhaust fans. If you don't have a generator, immediately prop the doors open and open the ridge vent if there is one. Plastic pots can be placed in the louvers of the exhaust fan to hold them open and let air enter the greenhouse. Shower the plants with a fine mist of water and keep the greenhouse floors wet. The water that evaporates off the plants will cool the leaf temperature.

- **Loss of water**—If there is a warning ahead of time that the water will be off, all plants should be watered before the shut off time. Fill large containers with water and use them as reservoirs for later use. For an unexpected water loss keep the fans running to cool the house and make sure the pump on the evaporative cooling system does not run dry. If it does, shut the motor off to prevent the pump from burning up. If the water is going to be off for a long period of time you can place cheesecloth or any other light colored material over the plants to shade them.

- **Ruptured greenhouse covering**—An extra roll of poly or a few sheets of rigid covering material should always be on hand. Any greenhouse coverings can be temporarily patched in an emergency, if the materials are on hand.

OBJECTIVE 10

List energy saving measures for greenhouses.

The cost of heating a greenhouse in the winter is substantial but there are steps a grower can take to conserve energy.

- **Insulate north wall**—Very little usable light enters a greenhouse through a north wall; since this is the direction of the prevailing winter wind many growers choose to construct this wall of solid material, insulate it and paint it white to reflect light.

  NOTE: A solid north wall is estimated to save 5-10% on heating cost.

- **Install heat shields**—These are curtains that are pulled from eave to eave at night so only the actual growing space is heated.

  NOTE: This system is usually automated but can be applied manually. The estimated savings is approximately 40%.

- **Install double layer coverings**—Most of the new rigid coverings have a 6-9mm air space between layers and are very energy efficient.

  NOTE: Covering a greenhouse with two layers of plastic, and leaving a dead air space between the layers, will lower heating costs by about 40%.

- **Build gutter connected houses**—Most of the heat lost from a greenhouse is through the walls that are exposed to outside air. The heat from four free standing houses will be lost from eight sidewalls; these same houses constructed in a gutter connected manner will only lose heat from two sidewalls.

  NOTE: By building greenhouses in a gutter connected manner the heating cost is reduced by about 50%.

- **Seal cracks and crevices**—Make sure any holes or gaps are sealed; the new polyurethane foam in a can works well for sealing small areas.

- **Install soil perimeter insulation**—Extruded polystyrene can be placed between the soil and the stem wall.

OBJECTIVE 11

Discuss cold frames and hot beds.

- Cold frames and hot beds are small structures generally used for producing cool season plants or hardening off transplants. They have been used for many years and are popular with home owners. The major difference between a cold frame and a hot bed is the heating source. A cold frame has no source of heat except for solar radiation collected during the daylight hours. A hot bed relies on some continuous source of heat. Years ago hot beds were heated by decomposing manure, but today electric heating cables are commonly used.

  The construction of a cold frame or hot bed is roughly the same. The frames should face south to collect as much sunlight as possible and have a transparent covering on top. Many people use old storm windows or a wooden frame with a greenhouse covering. The north wall of the structure is approximately 18-24 inches tall and can be made of wood. The side walls are also made of wood and decrease in height as they reach the south wall. A height of 8-10 inches is common for the south wall. This declining angle is so maximum sunlight will enter the unit. Soil is mounded against the north and side walls to act as insulation. The transparent cover is laid on top of the frame and should fit tightly enough to keep cold air from entering. Some people paint the interior of a cold frame or hot bed white to increase light intensity. Plants can be grown either directly in the soil inside the frame, or pots and flats may be placed inside the frame.

If the weather is clear and the sunlight is bright, the lid will have to be propped open about 4-6 inches during the day. Even though the air temperature outside is very cool, the temperature inside the frame quickly rises due to heating by the sun. The lid should be closed a couple of hours before sunset trapping heat for the night. Some growers will cover cold frames and hot beds with a tarpaulin or other cloth in the evening for extra insulation. This treatment will depend on the expected night temperature and the cold tolerance of your crop.

DESIGNING AND CONSTRUCTING GREENHOUSES

NAME ______________________________ SCORE _______

OBJECTIVE 12

Calculate building cost on a per square foot basis.

INTRODUCTION

The growing space in a greenhouse is generally limited to the amount of floor space, or square footage available. Because of this, the cost of a greenhouse is expressed as $ XX per square foot. When building a greenhouse the cost must be calculated on a square foot basis. The activity on this assignment sheet emphasizes this area.

DIRECTIONS

Use the information and itemized list of materials to calculate:

1. The total cost to build the greenhouse.
2. The cost per square foot.

EXAMPLE: Use the following method to determine the cost per square foot:

- Calculate the amount of total square footage in the greenhouse. To get this figure multiply the length of a greenhouse by its width. These numbers must be in feet, and not inches.
- Divide the total cost of the structures by the square footage it contains. This figure is the cost per square foot.

The greenhouse that is being built is 35′ x 90′ in size and uses the following materials:

Materials	**Cost**
Greenhouse frame	$4995.00
Polyethylene	213.50
Poly-locks	210.00
Exhaust fans	1812.00
Unit heaters	1208.00
Fan jet	736.00
Kool-cel	560.00
Thermostats	175.00
Concrete	650.00
Hired labor	850.00

1. What is the total cost for the greenhouse?________________

2. What is the greenhouse cost per square foot?______________

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ASSIGNMENT ANSWERS

DESIGNING AND CONSTRUCTING GREENHOUSES

I

ASSIGNMENT SHEET 1

1. $11,409.50
2. $3.62

WRITTEN TEST

DESIGNING AND CONSTRUCTING GREENHOUSES

I

NAME ______________________ SCORE ________

OBJECTIVE 1

Match terms associated with greenhouses and greenhouse construction to their correct definitions. Write the correct letters in the blanks.

____ 1. A system of securing polyethylene coverings on the greenhouse

____ 2. A rigid greenhouse covering that is made of double layers, has high light transmission, is flame retardant and has the strongest resistance to breakage

____ 3. The components used as a greenhouse frame

____ 4. A flexible film that is used as a greenhouse covering

____ 5. A greenhouse that is attached to other greenhouses at the gutter

____ 6. Semicircular shaped pieces of metal that form the frame of a quonset greenhouse

____ 7. A greenhouse covering that has the highest light transmission; comes in rigid panels that are especially made for greenhouses; has the longest life expectancy and high maintenance requirements

____ 8. A transparent double layer material used as a greenhouse covering; it is rigid, flammable and has moderate resistance to breakage

____ 9. An interconnecting group of framing members that form the roof in a ridge and peak greenhouse

____ 10. A single greenhouse not attached to any other greenhouse

a. Glass
b. Stem wall
c. Poly view
d. Poly lock
e. Purlins
f. Foundation
g. Acrylic
h. Half truss
i. Polycarbonate
j. Bows
k. Hothouse
l. Free standing greenhouse
m. Greenhouse
n. Greenhouse cluster
o. Fiberglass
p. Truss
q. Clear plastic
r. Structural material
s. Frame

___11. A structure covered with light transmitting material; the environment is controlled for the purpose of producing plants

___12. A group of greenhouses in the same area

___13. A framing member which runs the length of a greenhouse roof and holds the bows and trusses upright

___14. A short rigid wall that is the foundation of a greenhouse and where the covering is attached; usually composed of concrete, cinder blocks, or wood

___15. A semi-rigid covering material made by embedding strands of fiber in a plastic resin

t. Polyethylene

u. Gutter connected greenhouse

v. Greenhouse range

w. Rafters

OBJECTIVE 2 **List factors to be considered before building a greenhouse.** Write five factors in the space provided.

OBJECTIVE 3 **List legal and building requirements for greenhouse construction.**

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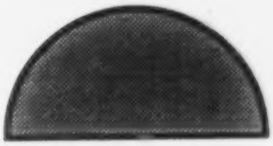
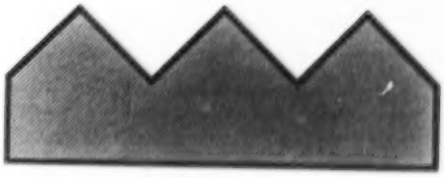
OBJECTIVE 4 **Match the different types of greenhouse designs to their correct illustrations.** Write the correct letters in the blanks.

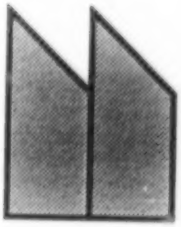
a. Lean-to	d. Quonset
b. Ridge and furrow	e. Sawtooth
c. Ridge and peak	f. Gothic



1. ________________



2. ____________________



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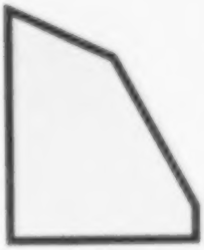
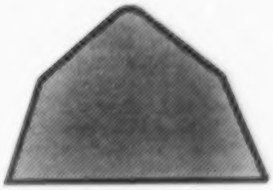
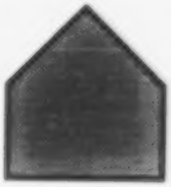


4. ____________________



5. ____________________



6. ____________________

OBJECTIVE 5 **Describe the different types of flooring used in greenhouses.**

1. Bark —

2. Concrete —

3. Gravel —

4. Mixed flooring — ______________________________

____

____

____

____

5. Soil — ______________________________

____

____

____

____

OBJECTIVE 6

Select from a list true statements concerning heating and cooling system. Write an "X" in the blank before each true statement.

____ 1. Infra-red heating only warms solid objects.

____ 2. Root zone heating requires more energy than steam heating.

____ 3. Greenhouse heaters do not have to be vented.

____ 4. A fan jet mixes the air inside a greenhouse.

____ 5. A unit heater is composed of a combustion chamber, heat exchanger, and a blower.

____ 6. Evaporative cooling is the most commonly used cooling system in the greenhouse industry.

____ 7. If a grower uses a hot water heating system he or she may apply the heat directly to the bench.

____ 8. Fog cooling systems do not use ventilation pads.

____ 9. Exhaust stacks should be 3 inches above the highest point of the roof.

____ 10. Power vents are required on all quonset greenhouses.

____ 11. Steam heating is the most prevalent method of greenhouse heating.

____ 12. Solar heating has not been developed to the stage where a greenhouse can be completely heated by this method.

OBJECTIVE 7

Select from a list true statements concerning drainage. Write an "X" in the blank before each true statement.

____ 1. Gravel, bark or soil floors become saturated with water quickly.

____ 2. If gravel, bark or soil floors are used, several open trenches should be dug to allow proper drainage.

____ 3. If concrete floors are used, they should be perfectly level to avoid wasteful runoff.

____ 4. A greenhouse operator is responsible for controlling waste water from his or her business.

____ 5. If you are in an urban location a local sewage disposal system will probably be used.

____ 6. The city may have restrictions on what may be discharged into the system.

____ 7. In a rural area a septic tank or sewage lagoon will be used.

OBJECTIVE 8

Select from a list true statements concerning bench type, materials and layout. Write an "X" in the blank before each true statement.

____ 1. Ground beds are commonly used today.

____ 2. Raised benches should be 12 inches above the floor.

____ 3. Growing plants on the greenhouse floor can cause poor plant growth and unhappy employees.

____ 4. Peninsular benching uses three major aisles in the greenhouse.

____ 5. Parallel benching is space efficient.

____ 6. Ebb and flow benches allow the crop to be watered by flood irrigation.

____ 7. Movable benches are the most space efficient.

____ 8. Concrete blocks and redwood lath make good raised benches.

OBJECTIVE 9

Discuss backup emergency systems. Tell what you would do in your greenhouse in the following emergency situations.

1. The outside layer of polyethylene covering gets a 2 foot tear on December 3.

2. The water will be shut off tomorrow from noon until 5:00 p.m.

3. The natural gas line to your greenhouse is shut off due to a leak and it is 28° F outside.

4. The electricity goes off at 3:00 p.m. on July 17.

OBJECTIVE 10

List energy saving measures for greenhouses. Write four measures in the space provided.

OBJECTIVE 11 **Discuss cold frames and hot beds.**

1. Discuss how to build a cold frame.

2. Describe the major difference between a cold frame and a hot bed.

NOTICE The following assignment sheet is not part of the written test. If this activity has not been completed, check with your instructor.

OBJECTIVE 12 **Calculate building cost on a per square foot basis.** SCORE ______

WRITTEN TEST ANSWERS

DESIGNING AND CONSTRUCTING GREENHOUSES

I

OBJECTIVE 1

1. d
2. i
3. r
4. t
5. u
6. j
7. a
8. g
9. p
10. l
11. m
12. v
13. e
14. b
15. o

OBJECTIVE 2

Answer should include five of the following:

- Accessibility
- Expandability
- Markets
- Orientation
- Personnel
- Topography
- Utilities
- Water

OBJECTIVE 3

Answer should include the following:

- Zoning restrictions
- Building permits
- Inspections

OBJECTIVE 4

1. d
2. b
3. e
4. a
5. f
6. c

OBJECTIVE 5

1. **Bark**—A nonpermanent flooring material that is expensive in the long run. Initially attractive but soon decomposes or is compressed into the soil below. Difficult to move carts or equipment, cannot be cleaned or pasteurized, and harbors weeds and insects.

2. **Concrete**—A permanent flooring that is expensive initially but inexpensive in the long run. Is easy to clean and sterilize, and allows the use of carts and machinery.

3. **Gravel**—A nonpermanent flooring that is commonly used. It does not allow the easy use of carts or equipment, it harbors weeds, insects and diseases and will eventually become embedded in the soil below.

4. **Mixed flooring**—Floors that are made of two different materials used in specialized areas for specific reasons. Many greenhouses have concrete aisles with gravel under the benches. The concrete is used for customer safety and movement of equipment within the house. The gravel covers the soil and gives a neat looking appearance.

5. **Soil**—The worst choice of flooring. A grower has decided not to put down any floor material and simply walks on the dirt. This type of floor is a hazard to your employees and customers due to the slippery nature of soil. Weeds and insects can become severe problems. Foliar diseases may appear on your crops due to high humidity.

OBJECTIVE 6 1, 4, 5, 6, 7, 8, 12

OBJECTIVE 7 1, 4, 5, 6, 7

OBJECTIVE 8 3, 6, 7, 8

OBJECTIVE 9

Answer should include the following:

1. Patch by taping an extra piece of plastic over the ruptured area.
2. Water plants thoroughly before noon. Collect large containers of water for emergencies.
3. Start the portable backup heaters. Crack vent to let exhaust escape.
4. Start generator if you have one and run fans. If you have no generator, open doors and vents. Mist plants to keep cool and wet floors.

OBJECTIVE 10

Answer should include any four of the following:

- Insulate north wall
- Install heat shields
- Install double layer coverings
- Build gutter connected houses
- Seal cracks and crevices
- Install soil perimeter insulation

OBJECTIVE 11

1. Answers should include the following:
   - It should face south
   - North wall 18-24 inches tall
   - South wall 8-10 inches tall
   - Slopes to allow sun penetration
   - Cover with transparent material
   - Mound soil on outside of the north and side walls for insulation
2. Cold frames use the heat of the sun to warm plants. A hot bed uses a continuous source of heat such as electricity.

OBJECTIVE 12

Refer to answers to Assignment Sheet 1.

OBJECTIVE SHEET

CONTROLLING THE GREENHOUSE ENVIRONMENT

II

INTRODUCTION

Top quality greenhouse plants can only be produced when the growing environment is suited to the crop. A greenhouse grower must be knowledgeable of each crop's requirements and then be able to adjust the temperature, light intensity and watering methods to meet these requirements.

UNIT OBJECTIVE

After completing this unit, the student should be able to correctly control the growing environment of a greenhouse. The student will demonstrate these competencies by completing the assignment sheets, job sheets and written test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with watering methods to their correct definitions.
2. Select from a list true statements concerning temperature control.
3. Complete statements regarding greenhouse light intensity.
4. Match shading products to their descriptions and uses.
5. Compare supplemental lighting systems.
6. List methods for controlling humidity.
7. Identify important components of water quality.
8. Identify proper temperatures for greenhouse crops. (Assignment Sheet 1)
9. Demonstrate the ability to
   a. Apply interior shade cloth. (Job Sheet 1)
   b. Assemble a tube watering system. (Job Sheet 2)
   c. Correctly hand water a potted plant. (Job Sheet 3)
   d. Test water pH. (Job Sheet 4)

PREPARATION

- Obtain materials to supplement unit.

  NOTE: See Suggested Resources.

- Review instructional outline for this unit. Modify time frames to suit class needs and plan activities for each class period.
- Study the specific objectives to determine those you will cover in your presentation. Decide also which objectives should be taught to which students.
- Determine scope and sequence of objectives that you add. Design and develop support materials, including evaluation techniques, for additional objectives.
- Determine how you will schedule time for students to demonstrate competence in the required procedures.
- Make arrangements to tour local greenhouses.
- Make arrangements for guest speakers. Supply speakers with specific objectives and other appropriate sections of the unit.

DELIVERY

Objective 1

- Introduce the topic of controlling the greenhouse environment. Stress the impact that the environment will have on plant health.
- Discuss the different watering methods.
- Take students on a tour of the school's greenhouse or a commercial greenhouse to observe environmental control systems. Make sure to point out the watering methods, temperature controls, supplemental lighting and shading systems.

Objectives 2 and 3

- Discuss temperature control.
- Discuss light intensity.
- Demonstrate to students how to use a light meter.

- Have students take light measurements in the greenhouse, outdoors and in the classroom.

Objectives 4 through 6

- Discuss shading products. Bring in samples of different shading products.
- Discuss supplemental lighting systems.
- Discuss methods for controlling humidity.

Objective 7

- Discuss important components of water quality.
- Demonstrate to students how to use a pH meter. Give students opportunities to use a pH meter.
- Contact your local extension service for information about water analysis laboratories in your area.
- Send a water sample to a laboratory for analysis.

APPLICATION

Objective 8

- Use Assignment Sheet 1 to teach students how to find information on crop culture and temperature requirements.

Objective 9

- Use Job Sheet 1 to teach students how to apply interior shade cloth.
- Use Job Sheet 2 to teach students how to assemble a tube watering system.
- Use Job Sheet 3 to teach students how to hand water a potted plant.
- Use Job Sheet 4 to teach students how to test water pH.

EVALUATION

Practical Test

- Explain to students that they will be asked to demonstrate procedures on the job sheets to complete the practical test.
- Describe the rating scale used on the practical test.

- Give practical test.
- Reteach and retest as necessary.

Written Test

- Explain to students that they will be asked to demonstrate on the written test actions listed in the specific objectives.
- Give written test.

  NOTE: Written test may be given in sections if desired.

- Evaluate students on assignment sheet activities if not previously done.
- Reteach and retest if necessary.
- Complete appropriate section of competency profiles.
- Review individual and group performance in order to evaluate teaching methods. Adjust scope, sequence, or instructional approaches for additional lessons as required.

SUGGESTED RESOURCES

Audiovisual Materials

- *How to Grow Plants in a Greenhouse*. 1/2" VHS, color, 47 min., 1988, Burpee, Kartes Video Communications. Available from Burpee, Kartes Video Communications, 7225 Woodland Drive, Indianapolis, IN 46278. Author and researcher Jeff Ball demonstrates the latest advances in greenhouse design and management and teaches proven techniques for nurturing plants in a controlled environment.

  NOTE: This video is available to Oklahoma teachers on a free-loan basis. Oklahoma teachers may order this video from the Oklahoma Department of Vocational and Technical Education, Resource Center, ATTN: Instructional Media Specialist, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074, phone 800-522-5810. Out-of-state teachers must order from the address listed with the video.

Publications

- Nelson, Paul V. *Greenhouse Operation and Management*, 3rd ed., Reston Publishing Co., Reston, Virginia, 1985.

Other Media

- Obtain a light meter for student use.
- Write seed companies and request catalogs for students.
- Obtain samples of shade fabrics.

UNIT REFERENCES

- Nelson, Paul V. *Greenhouse Operation and Management*, 3rd ed., Reston Publishing Co., Reston, Virginia, 1985.
- *Introduction to Horticulture*, Curriculum and Instructional Materials Center, Oklahoma Department of Vocational and Technical Education, Stillwater, Oklahoma, 1990.

BASIC ACADEMIC SKILLS

The following table identifies the basic academic skills that are reinforced in this unit of instruction. These basic academic skills were identified using *The Basic/Essential Skills Taxonomy*, 2nd edition, and verified during the validation process.

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 1	Language Arts 013	Applies/Uses	Definitions	
	Science 466	Identifies	Definitions	
	Science 467	Identifies	Definitions	Operational
OBJECTIVE 2	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity
	Science 467	Identifies	Definitions	Operational
OBJECTIVE 3	Science 320	Describes	Light	
OBJECTIVE 4	Science 467	Identifies	Definitions	Operational
	Science 337	Describes/ Explains	Matter	
	Science 474	Identifies	Matter	Physical properties
	Science 475	Identifies	Matter	Structure
OBJECTIVE 5	Language Arts 013	Applies/Uses	Definitions	
	Science 467	Identifies	Definitions	Operational

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 6	Language Arts 132	Comprehends	Information-written	
	Language Arts 038	Collects/ Organizes	Information-oral/written	
	Science 388	Describes/ Explains	Plants	Water
OBJECTIVE 7	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity
	Science 466	Identifies	Definitions	
OBJECTIVE 8	Language Arts 132	Comprehends	Information-written	
	Science 387	Describes/ Explains	Plants	Temperature --role of
OBJECTIVE 9a	Language Arts 035	Attends	Directions/ task	
	Science 045	Applies/ Uses	Scientific method	Analysis--qualitative/ quantitative
OBJECTIVE 9b	Language Arts 035	Attends	Directions/ task	
	Science 489	Measures	Distance/ length	
OBJECTIVE 9c	Language Arts 035	Attends	Directions/ task	

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	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 9d	Language Arts 035	Attends	Directions/ task	
	Science 040	Applies/ Uses	Laboratory techniques	
	Science 045	Applies/ Uses	Scientific method	Analysis-- qualitative/ quantitative

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CONTROLLING THE GREENHOUSE ENVIRONMENT

OBJECTIVE 1

Match terms associated with watering methods to their correct definitions.

- **Capillary mat watering**—Pots are placed on a water saturated fabric and the media absorbs water from the fabric

  NOTE: This fabric must have the ability to hold water for a long period of time. Algae does become a problem on the wet mat after a few weeks.

- **Drip tube watering**—Each individual pot receives drops of water from an emitter on the end of a spaghetti tube

  NOTE: This system is very popular because many pots can be watered at one time by a single employee. These tubes are reusable and easily pasteurized.

- **Flood watering**—A tray containing pots is filled with water and the plants absorb the water

  NOTE: Ebb and flow benches utilize the flood watering method. Diseases can be spread from pot to pot with this method.

- **Hand watering**—Requires an employee to water each pot individually using a hose and water breaker; this is the most labor intensive method and is very expensive

  NOTE: Water flats early in the morning so the leaves will dry and reduce disease problems.

- **Overhead watering**—Water is sprayed over the top of plants with irrigation sprinklers

  NOTE: This method is not usable in the greenhouse because of foliar disease problems. It is used with outdoor field stock but wastes large amounts of water.

OBJECTIVE 2 **Select from a list true statements concerning temperature control.**

The temperature maintained in a greenhouse has a large effect on crop quality. Poor plant growth, stunting, disease or chlorotic foliage can be due to improper temperatures. It is essential that the grower know the correct temperature requirements for each crop and that these temperatures be maintained in the greenhouse.

- **Thermostats**—Sensing devices used to turn the heating and cooling equipment on and off. There are many types of thermostats available and they will require frequent calibration. Generally, separate thermostats will be required for heating and cooling. There should be at least a 6° F temperature difference between the heating and cooling settings. This will allow for the few degrees of inaccuracy in the thermostats, and also prevent the cooling and heating from operating at the same time. A 10°-15° F temperature difference is more commonly found between the two systems.

  NOTE: Newer greenhouses are controlled by computers that use sensing devices.

- **Location**—Since the greenhouse temperature is being adjusted to suit the plants, the sensor should be centrally located and at plant height. Make sure sunlight does not directly shine on the thermostat and cause a faulty reading.

- **Day-night thermometer**—These devices should be in every greenhouse located at plant height. These thermometers let the grower know what the high and low temperatures were for the previous 24 hour period. They also tell the grower how accurate the thermostat is and can alert personnel to problems in the heating or cooling system.

  NOTE: Many people falsely assume that having the temperature improperly set a few degrees will not hurt the crop.

Production time can be increased by 10-12 days, or crop quality lowered, if temperatures are too low.

OBJECTIVE 3

Complete statements regarding greenhouse light intensity.

Adequate light intensity plays a major role in healthy plant growth. When light levels are too low plant growth becomes weak and spindly. If the light intensity is too high chlorophyll will be destroyed and foliage will appear bleached out. Plant death can be caused by improper light levels.

- **Optimum light levels**—Every species of plant has an ideal light level and the grower must be aware of the requirement. Generally plants are categorized into three groups:
    - Low light plants; require 1000 foot candles or less of light.
    - Medium light plants; require 1000-4000 foot candles of light.
    - High light plants; require more than 4000 foot candles of light.
- **Measuring light intensity**—Measuring light intensity is done with an instrument called a light meter. It is a relatively inexpensive piece of equipment that measures light intensity, but not the quality of light. The readings are given in units called foot candles; the amount of light produced by a candle one foot away. This in an old term but it is still commonly used today. Newer equipment used to measure light is very expensive and its units of measure are microeinsteins. These machines give readings of both light quantity and light quality. Due to the expense they are not commonly found in the commercial greenhouse industry.
- **Taking measurements**—Light measurements should be taken at plant height and on a clear day. The best time to take a measurement is at 12 o'clock noon. When taking a measurement, hold the meter upright and do not tilt it toward the sun. You should notice that the closer a plant is growing to the floor, the lower the light intensity.
- **Age of the cover**—As a greenhouse cover gets older, the light transmission is reduced. There are also differences in light transmission due to the type of covering material. Seasonal changes will have a big effect on light levels entering the greenhouse.

OBJECTIVE 4

Match shading products to their descriptions and uses.

At some time most greenhouse growers are faced with the need to reduce the light intensity inside the greenhouse. It may be due to a new greenhouse cover, the geographic location, or because of crop requirements. To reduce the light levels a grower will use some type of shade product. There are two ways shade products may be applied.

- **Exterior application**—This involves putting the shade product on the outside of the greenhouse. Here it is constantly exposed to the weather. If the greenhouses are tall or large it is a difficult job to apply the shade. There are two products that are used for outdoor shade application:
    - Polypropylene fabric—A dark colored, woven plastic fabric that is custom made to fit any size greenhouse (all fabric type shade materials have inherited the common name of "shade cloth"). It can be purchased in light reducing densities of 20-80% depending on the grower's need. This cloth is stretched across the roof of the house and attached on the eave or side walls. It must be fastened securely to prevent the wind from blowing it off. This fabric is durable and reusable but initially expensive.
    - Shading compound—A white wash type paint that is sprayed on the greenhouse roof. The amount of light reduction depends on how heavily the white wash is applied. This compound will last the entire summer and must be washed off in the fall when shade is no longer desired. The paint is cheap, fairly easy to apply, but hard to remove. It collects in cracks, crevices, corners, and on rough areas of the cover. Shade compound must be applied every year.

  The use of exterior shade will lower the interior greenhouse temperature a few degrees, but not a great deal. Exterior shade reduces the light intensity in the entire greenhouse; this might be a problem if an area of higher light is needed for a special purpose.

- **Interior application**—This involves placing the shade product inside the greenhouse where the material is not exposed to the weather. Installation is simple and shade levels can be adjusted for special needs. Interior shade cloth is white in color, reflects light and does not reduce greenhouse temperatures. The products most commonly used are:

    - Poly spun fabric—A lightweight interfacing type fabric. It can be purchased in several light-reducing weights and is semi-durable; usually it is reused for 2-3 years. Application is done by clothespinning it to a frame or wire.

    - Cheese cloth—The old standard shade cloth commonly used 20 years ago. It is lightweight and 100% cotton so it is not as durable as poly spun. This fabric is becoming difficult to obtain.

    - Dutch made Ludwig Swenson shade fabric uses narrow strips of aluminum embedded in a net fabric. The amount of shading produced depends on how close the strips of aluminum are spaced apart. This is a new system that significantly lowers the greenhouse temperature along with producing lower light intensities. It was designed for automatic application and has a folding system like mini blinds. This shade system is easily connected to a photocell and will only operate when the light intensity reaches a designated brightness.

- **Black clothing**—During certain growth stages a crop may require a specific day length and the grower must manipulate the amount of light the plant receives. To imitate short day conditions, plants are completely covered with a dark cloth for several hours, usually from 5 p.m. till 8 a.m., to completely exclude all light. This treatment has become known as black clothing. Standard shade fabrics are not dense enough to exclude light and will not work for black clothing purposes. A tightly woven, black cotton fabric is commonly used, and many growers use black poly. The cotton cloth will breathe and let trapped heat escape, the poly does not release the heat and can cause growth problems.

OBJECTIVE 5

Compare supplemental lighting systems.

During the fall and winter months many growers become concerned about cloudy weather. Plant growth is reduced and stems tend to stretch. Supplemental lighting systems are used for two reasons.

- **Increase light intensity**--In much of the United States cloudy weather persists for several months. To combat these low light levels growers will install high intensity lights. These lights are expensive to purchase, and there are many types, each with a different light spectrum. Metal halide, high pressure sodium and high intensity discharge are the most common. They are large, bulky and are permanently mounted in the greenhouse. The lights are operated during the daytime to supplement the natural light but may be illuminated until as late as 11 p.m. These supplemental lights will improve crop quality and reduce production time but are costly to burn. Careful consideration should be given to their use.

- **Manipulate day length**—Lighting systems are also used to simulate long day conditions. Any greenhouse that produces pot mums will need a light system. When increasing day length, growers are only concerned about light duration, not intensity. Long day lighting is inexpensive to install and operate; it uses 100 watt household bulbs spaced four feet apart and three feet above the plants. The lights are on from 10 p.m. to 2 a.m. and can be controlled with a household light timer. This system can be moved easily from one greenhouse to another if needed.

OBJECTIVE 6

List methods for controlling humidity.

The humidity levels in a greenhouse contribute to the overall crop quality. If the humidity is too high plant diseases are encouraged, and the house is difficult to cool. If the humidity is too low foliar damage will appear, and the house will be harder to heat. Improper humidity levels will slow plant growth and reduce quality. A relative humidity of 60-70% is desired in the greenhouse and there are methods to correct humidity problems.

- **To increase humidity**—This is usually a problem in the winter months; forced air heating pulls the moisture out of the air resulting in low humidity. Below is a list of methods to increase the humidity.
  - Retain gravel floors under the benches. The water in the soil serves as a reservoir and evaporates into the greenhouse atmosphere.

  - Hose down the floors several times a day. The freestanding water will evaporate and humidify.
  - Install fog nozzles throughout the greenhouse and hook them to a timer. This will humidify the air and yet keep freestanding water off the floors and plants.

- **To lower humidity**—This is a common problem with poly houses and houses that are sealed very tightly. Excess moisture cannot escape through cracks and holes so it is held within the greenhouse. Excess moisture will damage sensitive electrical equipment, benches and the structure itself, as well as spread diseases. Below is a list of methods to reduce the humidity.
  - Ventilation. When the greenhouse is ventilated the moist internal air is replaced with drier outdoor air.
  - Use concrete floors. This will allow excess water to drain out of the house quickly.
  - Avoid hand watering. Automated systems do not waste large volumes of water and will help to keep the floors dry.
  - Water early in the day. The sun will quickly evaporate the excess water and daytime ventilation will remove the humid air from the greenhouse.
  - Keep the growing media as dry as possible. Water is evaporated from the pots as well as by transpiration. Running the plants on the dry side will reduce both processes.

OBJECTIVE 7

Identify important components of water quality.

A good water supply is vital to a greenhouse, it must be readily available and free of contaminates. Before buying or building a greenhouse, have a water sample analyzed for chemical composition and quality. Make sure to test for:

- **pH**—An indication of how acidic or alkaline the water is. A reading of 6.0 to 6.8 is normal. The pH is usually easy to adjust by adding acid or base before using.

- **Total soluble salts**—A number that accounts for all dissolved salts (K, Mg, Ca, Na, etc.). A reading of 1.0 mmhos/cm or less indicates safe water. If the water is high in salts nothing but reverse osmosis will remove the salt, and that is very expensive.

- **Bicarbonate levels**—These ions will bind with specific nutrients in the media and cause major problems. Plant symptoms include burnt leaf margins and chlorotic foliage.

- **Nutrient levels**—The minor elements are sometimes found in damaging quantities in water; especially boron, chloride and fluoride.

Water samples can be sent to a university laboratory or private laboratory for a complete water analysis.

DETERMINE THE INFLUENCE THAT ENVIRONMENT HAS ON PLANT HEALTH AND GROWTH

1. **Light**—Take two plants that require high light. Place one of the plants in a well lighted area and the other in a moderate to low lighted area. Monitor the plants and see if you notice any differences between them.
2. **Water**—Take two plants and water one by hand and the other by drip tubes. Monitor the plants and see if you notice any differences between them.
3. **Temperature**—Take two plants that require a moderate temperature. Place one plant where it is slightly cooler. Monitor the plants and see if you notice any difference between them.

NOTE: Coleus, African violet, pothos, Swedish Ivy and Airplane plant are a few plant species that can be used for this activity.

ASSIGNMENT SHEET 1

CONTROLLING THE GREENHOUSE ENVIRONMENT

II

NAME ______________________________ SCORE ________

OBJECTIVE 8

Identify proper temperatures for greenhouse crops.

INTRODUCTION

Objective 2 discusses the importance of knowing the proper temperature requirements for your crop and making sure the greenhouse environment meets the crop's needs. The activity on this assignment sheet emphasizes this area.

DIRECTIONS

Use the crop information on the next page to determine the correct growing temperatures for the crops. List the temperatures in the blanks provided.

Coleus

Germination temperature ______________

Growing temperature (night) ______________

Dianthus

Germination temperature ______________

Growing temperature (night) ______________

PARK'S COLORFUL COLEUS

ANNUAL 100,000 S L 70° 12 days

One of the most popular of all bedding plants because they remain neat and colorful throughout the summer and right up to frost. Also superb as pot plants and in hanging baskets. Coleus are easy to grow and have a long shelf life.

In the North, sow 9 weeks prior to anticipated sales date for sale in flats, 12 weeks prior for 4-inch pots. In the South, sow 8 weeks prior to sale in packs, 11 weeks in 4-inch pots. For maximum germination, keep soil temperature above 65° F. After germination, grow on at a steady night temperature of 60° F. Because Coleus is subject to damping-off, a post-transplant fungicidal drench is recommended. Pinch out flower buds if they form.

DIANTHUS

Grow-To-Sell Culture

New Dianthus varieties have been created to withstand the summer heat, and many are hardy enough to defy northern winters.

In the North, sow 11 weeks prior to sale in packs, 12-13 weeks prior to sale in 4-inch pots. In the South, sow 10 weeks prior to sale in packs, 11-12 weeks prior to sale in 4-inch pots.

Sow seed to a depth of 1/8-inch, germinate at 60° F. Transplant in 10-14 days to inserts or packs, and for most compact plants, grow cool (45° F-55° F). Avoid heavy feeding - Dianthus is sensitive to ammonia-based fertilizers. They flower in response to day length - during winter months provide bright light or extend day length at least 4 hours with artificial lights to produce the most uniform plants. If selling in 4-inch pots, grow on for 60 days after first transplanting, before shifting to pots. Water sparingly, particularly after bud formaion. Cycocel treatment same as for Carnations.

Used with permission of Park Seed Company, Greenwood, SC 29647-0001

ASSIGNMENT SHEET 1

Use the following criteria for evaluation:

- Coleus
  germination temperature above 65° F
  growing temperature (night) 60° F

- Dianthus
  germination temperature 60° F
  growing temperature (night) 45° F-55° F

JOB SHEET 1

CONTROLLING THE GREENHOUSE ENVIRONMENT

II

OBJECTIVE 9a

Apply interior shade cloth.

INTRODUCTION

A greenhouse grower must be able to provide the proper light intensity for the crop. The following procedure will familiarize you with shade cloth application.

EQUIPMENT SUPPLIES

- Light meter
- Shade cloth
- Pinch type clothespins
- Wooden frame or guide wire

PROCEDURE

1. Determine the current light intensity at the designated location.
2. Determine what strength of shade cloth will be needed to make the area suitable for low light plants.
3. If shade cloth is being placed overhead, run a guide wire to support the fabric.
4. If a wooden shade chamber is being constructed on the bench make sure it is tall enough to allow workers to reach the plants easily.
5. Stretch the shade cloth in place and pull it tight. Clip it in place with clothespins or use a staple gun to tack it to the frame.
6. Measure the light intensity and check to see if it is suitable for low light plants.
7. If the intensity is too high, apply another layer of cloth.
8. Put away equipment and supplies and clean work area.

JOB SHEET 2

CONTROLLING THE GREENHOUSE ENVIRONMENT

II

OBJECTIVE 9b

Assemble a tube watering system.

INTRODUCTION

A tube watering system will reduce a greenhouse grower's labor expense. One person can water an entire greenhouse in a few minutes. The following procedure is for assembling a tube watering system.

EQUIPMENT AND SUPPLIES

- Black poly 1/2" pipe
- Hole punch
- Drip tubes
- Wire
- Male hose end fitting
- Threaded end cap
- Knife
- Screwdriver
- 2 small radiator clamps
- 200 mesh filter or screen

PROCEDURE

1. Determine if a filter or screen is needed. City water systems have water that is relatively free of dirt and debris. If well, river or lake water is used a filter or screen must be used to remove the dirt and prevent clogged emitters.
2. Determine the size of pots to be grown and the spacing. A tube watering system is set up to fit the pot size and the spacing of pots on the bench. It may help to space out empty pots on the bench to get the spacing correct.
3. Run a piece of black pipe down the length of the growing area that will have the watering system. It is usually placed in the center of the bench.
4. Secure the pipe to the bench with wire.

5. Determine the spacing of the drip tubes on the pipe. The tubes are usually clustered in groups of 3 or 4.

6. Punch holes in the top side of the pipe with the hole punch and immediately push the drip tube into the hole.

7. Insert the drip tube so it penetrates into the pipe about 3/4 of the diameter of the pipe.

8. Insert all tubes. The hole in the pipe will swell shut around the drip tube and hold it tightly in place.

9. On the end of the pipe closest to the water supply, attach a male hose fitting and secure it with a radiator clamp. This will be where the water enters the system.

10. Turn on the water and flush the poly pipe. This washes out any debris that might be in the pipe and prevents the emitters from becoming clogged.

11. After the line has been flushed, cap off the far end with the threaded cap. This type of cap is used so the line can be flushed later if needed.

12. If needed install a 200 mesh filter where the water enters the system.

13. Put away equipment and supplies and clean work area.

JOB SHEET 3

CONTROLLING THE GREENHOUSE ENVIRONMENT

II

OBJECTIVE 9c

Correctly hand water a potted plant.

INTRODUCTION

A large number of greenhouse products are watered by hand. Watering is critical in the production cycle and improper watering techniques will result in large plant losses. The following procedure is for proper hand watering technique.

EQUIPMENT AND SUPPLIES

- Potted plants
- Hose
- Water wand
- Water breaker

PROCEDURE

1. Turn the water on and adjust the flow rate so the water coming out of the breaker has just begun to break into individual streams. If the force is too high, media will be washed out of the pots, and if it is too low the watering procedure will be slow and the media will be unevenly watered.
2. Put the water directly on the potting media and not on the foliage or flowers. If hand watering flats, it is impossible not to get some water on the foliage and flowers.
3. Apply enough water so a small amount of excess drips out the bottom drain holes.
4. Hang up the hose and breaker when finished watering. Leaving the breaker on the floor exposes it to disease.
5. Put away equipment and supplies and clean work area.

JOB SHEET 4

CONTROLLING THE GREENHOUSE ENVIRONMENT

II

OBJECTIVE 9d

Test water pH.

INTRODUCTION

A pH meter is a useful tool in the greenhouse and each grower should be able to accurately operate the meter. This procedure is for testing your greenhouse water.

EQUIPMENT AND SUPPLIES

- pH meter
- Glass beakers
- Standard solutions
- Distilled water

PROCEDURE

1. Pour a small amount of pH 4 standard solution into a beaker.
2. Immerse the pH probe and take the reading. It should read 4.0; if it does not adjust the calibration dial until it reads 4.0.
3. Remove probe and rinse with distilled water.
4. Test the accuracy by immersing the probe in pH 7.0 standard. Readjust if needed.
5. Remove probe and rinse with distilled water.
6. Rinse the remaining beaker with tap water several times. After rinsing fill it with water, test and record the pH.
7. Remove probe and rinse with distilled water, dry with tissue.
8. Put away equipment and supplies and clean work area.

JOB SHEET 1

Apply interior shade cloth.

Student's name ____________________________ Date ___________

Evaluator's name ____________________________ Attempt no. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Determined the current light intensity at the designated location.	_____	_____
2. Determined what strength of shade cloth needed to make the area suitable for low light plants.	_____	_____
3. If shade cloth was being placed overhead, ran a guide wire to support the fabric.	_____	_____
4. If a wooden shade chamber was being constructed on the bench, made sure it was tall enough to allow workers to reach the plants easily.	_____	_____
5. Stretched the shade cloth in place and pulled it tight. Clipped it in place with clothespins or used a staple gun to tack it to the frame.	_____	_____
6. Measured the light intensity and checked to see if it was suitable for low light plants.	_____	_____
7. If the intensity was too high, applied another layer of cloth.	_____	_____
8. Put away equipment and supplies and cleaned work area.	_____	_____

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key). A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Shade cloth properly put in place	4	3	2	1
Correct amount of cloth for light intensity	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training

3 - Moderately skilled—Has performed job during training program; limited additional training may be required

2 - Limited skill—Has performed job during training program; additional training is required to develop skill

1 - Unskilled—Is familiar with process; but is unable to perform job

JOB SHEET 2

Assemble a tube watering system.

Student's name ______________________________ Date ____________

Evaluator's name ____________________________ Attempt no. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Determined if a screen or filter was needed.	_____	_____
2. Determined the size of pots and the spacing.	_____	_____
3. Ran a piece of black pipe down the length of the growing area that will have the watering system.	_____	_____
4. Secured the pipe to the bench with wire.	_____	_____
5. Determined the spacing of the drip tubes on the pipe.	_____	_____
6. Punched holes in the top side of the pipe with the hole punch and immediately pushed the drip tube into the hole.	_____	_____
7. Inserted the drip tube so it penetrated into the pipe about 3/4 of the diameter of the pipe.	_____	_____
8. Inserted all tubes.	_____	_____
9. On the end of the pipe closest to the water supply, attached a male hose fitting and secured it with a radiator clamp.	_____	_____
10. Turned on the water and flushed the poly pipe.	_____	_____
11. After the line had been flushed, capped off the far end with the threaded cap.	_____	_____

The student:	YES	NO
12. Installed a 200 mesh filter where the water entered the system.	____	____
13. Put away equipment and supplies and cleaned work area.	____	____

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key). A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Pipe spacing and layout correct	4	3	2	1
Drip tubes correctly installed	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training

3 - Moderately skilled—Has performed job during training program; limited additional training may be required

2 - Limited skill—Has performed job during training program; additional training is required to develop skill

1 - Unskilled—Is familiar with process; but is unable to perform job

PRACTICAL TEST 3

CONTROLLING THE GREENHOUSE ENVIRONMENT

II

JOB SHEET 3

Correctly hand water a potted plant.

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Turned the water on and adjusted the flow rate so the water coming out of the breaker has just begun to break into individual streams.	_____	_____
2. Put the water directly on the potting media and not on the foliage or flowers.	_____	_____
3. Applied enough water so a small amount of excess dripped out the bottom drain holes.	_____	_____
4. Hung up the hose and breaker when finished watering.	_____	_____
5. Put away equipment and supplies and cleaned work area.	_____	_____

EVALUATOR'S COMMENTS

____

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key). A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Proper water pressure	4	3	2	1
Plants uniformly watered	4	3	2	1
Correct amount of water	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training
3 - Moderately skilled—Has performed job during training program; limited additional training may be required
2 - Limited skill—Has performed job during training program; additional training is required to develop skill
1 - Unskilled—Is familiar with process, but is unable to perform job

PRACTICAL TEST 4

CONTROLLING THE GREENHOUSE ENVIRONMENT

II

JOB SHEET 4

Test water pH.

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Poured a small amount of pH 4 standard solution into a beaker.	____	____
2. Immersed the pH probe and took the reading.	____	____
3. Removed probe and rinsed with distilled water.	____	____
4. Tested the accuracy by immersing the probe in pH 7.0 standard. Readjusted if needed.	____	____
5. Removed probe and rinsed with distilled water.	____	____
6. Rinsed the remaining beaker with tap water several times. After rinsing filled it with water, tested the pH and recorded pH.	____	____
7. Removed probe and rinsed with distilled water, dried with tissue.	____	____
8. Put away equipment and supplies and cleaned work area.	____	____

EVALUATOR'S COMMENTS

____

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key). A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Calibration of equipment	4	3	2	1
Proper operation of equipment	4	3	2	1
Proper clean up and storage of equipment	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training

3 - Moderately skilled—Has performed job during training program; limited additional training may be required

2 - Limited skill—Has performed job during training program; additional training is required to develop skill

1 - Unskilled—Is familiar with process, but is unable to perform job

WRITTEN TEST

CONTROLLING THE GREENHOUSE ENVIRONMENT

II

NAME ______________________________ SCORE

OBJECTIVE 1

Match terms associated with watering methods to their correct definitions. Write the correct letters in the blanks.

____ 1. Requires an employee to water each pot individually using a hose and water breaker; this is the most labor intensive method and is very expensive

____ 2. Water is sprayed over the top of plants with irrigation sprinklers

____ 3. A tray containing pots is filled with water and the plants absorb the water

____ 4. Each individual pot receives drops of water from an emitter on the end of a spaghetti tube

____ 5. Pots are placed on a water saturated fabric and the media absorbs water from the fabric

a. Overhead watering

b. Osmatic watering

c. Drip tube watering

d. Flood watering

e. Gravity watering

f. Saturation watering

g. Hand watering

h. Capillary mat watering

OBJECTIVE 2

Select from a list true statements concerning temperature control. Write an "X" in the blank before each true statement.

____ 1. Thermostats are sensing devices used to turn heating and cooling equipment on and off.

____ 2. A day-night thermometer tells the grower what the high and low temperatures were for the previous 24 hour period.

____ 3. Most thermostats are self-calibrating.

____ 4. A thermostat should be located at plant height.

____ 5. The sun should shine directly on the thermostat.

____ 6. There should be at least a 6° F temperature difference between the heating and cooling settings on a thermostat. Generally there is a 10° F to 15° F difference between heating and cooling.

OBJECTIVE 3

Complete statements regarding greenhouse light intensity. Write the missing word in the blank.

1. Light intensity is measured with a ______________ .
2. Medium light plants require light intensities of _____ to __________ foot candles.
3. Light measurements should be taken at __________ height on a _________ day at ________________.
4. Low light plants require light intensities of under _________ footcandles.
5. High light plants require light intensities of more than ____________ footcandles.

OBJECTIVE 4

Match shading products to their descriptions and uses. Write the correct letter in the blank.

____1. A Whitewash type paint that is sprayed on the greenhouse roof

____2. Completely excludes all light

____3. A lightweight 100% cotton cloth commonly used 20 years ago

____4. A lightweight interfacing fabric which can be purchased in several light reducing weights

____5. Narrow strips of aluminum embedded in a net fabric

____6. Refers to all fabric type shade materials

____7. A dark colored, woven plastic fabric that is custom made to fit any greenhouse.

a. Polypropylene fabric

b. Black plastic

c. Ludwig Swenson fabric

d. Black clothing

e. Blocking compound

f. Cheesecloth

g. Shade cloth

h. Shadeout

i. Shading compound

j. Poly spun fabric

k. Light drape

OBJECTIVE 5

Compare supplemental lighting systems. Write an "i" in the blank if the statement is about increasing light intensity or an "m" if the statement deals with manipulating the day length.

____ 1. Lights used 10 p.m. to 2 a.m.

____ 2. Metal halide, high pressure sodium or high intensity discharge lights

____ 3. Inexpensive to operate

____ 4. 100 watt bulb, 4 feet apart and three feet above the plants

____ 5. Expensive to operate

____ 6. Expensive fixture and should be considered a permanent system

OBJECTIVE 6

List methods for controlling humidity. Answer the following questions.

1. What are three methods to decrease humidity in a greenhouse?

2. What are three methods to increase the humidity in a greenhouse?

OBJECTIVE 7 **Identify important components of water quality.** Write an "X" in the blank before important components of water quality.

____ 1. pH

____ 2. Percent algae

____ 3. Bacteria count

____ 4. Total soluble salts

____ 5. Softness

____ 6. Bicarbonate levels

____ 7. Nutrient levels

NOTICE The following assignment sheet and job sheets are not part of the written test. If these activities have not been completed, check with your instructor.

OBJECTIVE 8 **Identify proper temperatures for greenhouse crops.** SCORE ________

OBJECTIVE 9 **Demonstrate the ability to**

a. Apply interior shade cloth. RATING ________

b. Assemble a tube watering system. RATING ________

c. Correctly hand water a potted plant. RATING ________

d. Test water pH. RATING ________

99

WRITTEN TEST ANSWERS

CONTROLLING THE GREENHOUSE ENVIRONMENT

II

OBJECTIVE 1

1. g
2. a
3. d
4. c
5. h

OBJECTIVE 2

1, 2, 4, 6

OBJECTIVE 3

1. light meter
2. 1000, 4000
3. plant, clear, 12 o'clock noon
4. 1000
5. 4000

OBJECTIVE 4

1. i
2. d
3. f
4. j
5. c
6. g
7. a

OBJECTIVE 5

1. m
2. i
3. m
4. m
5. i
6. i

OBJECTIVE 6

1. Answer should include three of the following:
   - Ventilation
   - Concrete floors
   - Avoid hand watering
   - Keep growing media on the dry side
   - Water early in the day
2. Answer should include the following:
   - Gravel floors
   - Hose down floors during the day
   - Install fog nozzles

OBJECTIVE 7

1, 4, 6, 7,

OBJECTIVE 8

Refer to answers to Assignment Sheet 1.

OBJECTIVE 9 a-d

Refer to Practical Tests for Job Sheets 1 through 4.

OBJECTIVE SHEET

PREPARING GROWING MEDIA

III

INTRODUCTION

A good growing media is an essential part of a successful greenhouse. There are many premade media available on the market, and every grower has a preference. Some people prefer to blend their own media rather than purchase a mix. It is important that a greenhouse grower understand the characteristics of a good media and be able to adjust or devise a media to suit his or her needs.

UNIT OBJECTIVE

After completing this unit, the student should be able to select the proper premade media for a crop or blend a homemade media to fit the special needs of a crop. The student will demonstrate these competencies by completing the assignment sheets, job sheet and written test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. List the major functions of a growing media.
2. Match the major components of a growing media to their descriptions.
3. Discuss choosing a growing media.
4. Select from a list true statements about shredding and screening media components.
5. Complete statements concerning proper pasteurization procedures.
6. List the additives for a cubic yard of 3:1:1 peat:perlite:vermiculite soilless medium.
7. Arrange in order the proper procedure for blending media.
8. Describe incorporation of fertilizers into growing media.
9. Identify methods of adjusting media pH.
10. Select from a list true statements concerning proper storage procedures for media.
11. Calculate the volume of media required. (Assignment Sheet 1)
12. Calculate the volume of components required to blend a media. (Assignment Sheet 2)

13. Calculate the amount of additives required for a growing media. (Assignment Sheet 3)

14. Demonstrate the ability to blend a growing media. (Job Sheet 1)

SUGGESTED ACTIVITIES

PREPARING GROWING MEDIA

III

PREPARATION

- Obtain materials to supplement unit.

  NOTE: See Suggested Resources.

- Review instructional outline for this unit. Modify time frames to suit class needs and plan activities for each class period.
- Study the specific objectives to determine those you will cover in your presentation. Decide also which objectives should be taught to which students.
- Determine scope and sequence of objectives that you add. Design and develop support materials, including evaluation techniques, for additional objectives.
- Determine how you will schedule time for students to demonstrate competence in the required procedures.
- Make arrangements for guest speakers. Supply speakers with specific objectives and other appropriate sections of the unit.

DELIVERY

Objectives 1 and 2

- Introduce the topic of growing media. Stress the importance a growing media can have on plant health.
- Discuss the major functions of a growing media.
- Discuss the major components of a growing media.
- Show students examples of the various media components.
- Have students grow swedish ivy cuttings in containers of water, sand, perlite, and growing medium. Compare quality of growth.

Objectives 3 and 4

- Discuss choosing a growing media.
- Discuss shredding and screening media.

Objective 5

- Discuss proper pasteurization procedures. Stress safety procedures.

  NOTE: Chemical pasteurization procedures are not intended to be a class project or to be used in the classroom situation.

- Have students look up the various pasteurization supplies available in the A.H. Hummert catalog.

Objectives 6 through 8

- Discuss the proper procedure for blending media.
- Demonstrate how to correctly weigh and measure additives and components.
- Discuss the incorporation of fertilizers into growing media.

Objectives 9 and 10

- Discuss adjusting media pH.
- Demonstrate adjusting media pH.
- Discuss proper storage procedures for media.

APPLICATION

Objective 11

- Use Assignment Sheet 1 to give students practice in determining the volume of media required.

Objective 12

- Use Assignment Sheet 2 to give students practice in calculating the amount of components required to blend a media.

Objective 13

- Use Assignment Sheet 3 to give students practice in calculating the amount of additives required for a growing media.

Objective 14

- Use Job Sheet 1 to give students practice in blending a growing media.

EVALUATION

Practical Test

- Explain to students that they will be asked to demonstrate procedures on the job sheets to complete the practical test.
- Describe the rating scale used on the practical test.
- Give practical test.
- Reteach and retest if necessary.

Written Test

- Explain to students that they will be asked to demonstrate on the written test actions listed in the specific objectives.
- Give written test.

  NOTE: Written test may be given in sections if desired.
- Evaluate students on assignment sheet activities if not previously done.
- Reteach and retest if necessary.
- Complete appropriate section of competency profiles.
- Review individual and group performance in order to evaluate teaching methods. Adjust scope, sequence, or instructional approaches for additional lessons as required.

SUGGESTED RESOURCES

Audiovisual Materials

- *How to Grow Plants in A Greenhouse*, color 1/2" VHS, 47 min, Burpee, Kartes Video Communications, 1988. Available from Burpee, Kartes Video Communications, 7225 Woodland Drive, Indianapolis, IN 46278. Author Jeff Ball demonstrates the latest advances in greenhouse design and management, and teaches you proven techniques for nurturing plants in a controlled environment. This program covers custom mixing of potting medium for beds and containers.

  NOTE: This video is available to Oklahoma teachers on a free-loan basis. Oklahoma teachers may order this video from the Oklahoma Department of Vocational and Technical Education, Resource Center, ATTN: Instructional Media Specialist, 1500 West Seventh Avenue, Stillwater, OK 74074, 1-800-522-5810. Out-of-state teachers must order from the address listed with the video.

Other Media

- A.H. Hummert Seed Co. Catalog
  2746 Chouteau Ave.
  St. Louis, MO 6310
  1-800-325-3055
- Order the components and ingredients needed to blend a media.

UNIT REFERENCES

- A.H. Hummert Seed Co. Catalog, A.H. Hummert Seed Co., St. Louis, Missouri, 1989.
- Ball, Vic, *Ball Redbook*, 14th ed., Reston Publishing Co., Inc., Reston, Virginia, 1985.
- Manaker, George H., *Interior Plantscapes Installation, Maintenance, and Management*, 2nd ed., Prentice Hall, Inc., Englewood Cliffs, New Jersey, 1987.
- Nelson, Paul V., *Greenhouse Operation and Management*, 3rd ed., Reston Publishing Company, Inc., Reston, Virginia 1985.

BASIC ACADEMIC SKILLS

The following table identifies the basic academic skills that are reinforced in this unit of instruction. These basic academic skills were identified using *The Basic/Essential Skills Taxonomy*, 2nd edition, and verified during the validation process.

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 1	Language Arts 132	Comprehends	Information-written	
	Language Arts 038	Collects/ Organizes	Information-oral/written	
OBJECTIVE 2	Language Arts 013	Applies/Uses	Definitions	
	Science 466	Identifies	Definitions	
	Language Arts 136	Comprehends	Information-written	Charts/ tables/ graphs
OBJECTIVE 3	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
OBJECTIVE 4	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity
	Language Arts 013	Applies/Uses	Definitions	
OBJECTIVE 5	Language Arts 132	Comprehends	Information-written	
	Language Arts 139	Comprehends	Information-written	Context

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 6	Science 114	Describes/ Explains	Chemical reactions	
OBJECTIVE 7	Language Arts 146	Comprehends	Information-written	Sequence
OBJECTIVE 8	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
	Science 379	Describes/ Explains	Plants	Fertilization
OBJECTIVE 9	Science 058	Describes/ Explains	Acids/bases	pH
	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
OBJECTIVE 10	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity
OBJECTIVE 11	Mathematics 232	Solves	Proportion problems	Volume
	Mathematics 065	Computes	Multiplication	Decimals
	Mathematics 039	Computes	Division	Decimals
	OR			
	Mathematics 262	Uses calculator	Division	
	Mathematics 266	Uses calculator	Multiplication	

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 12	Mathematics 232	Solves	Proportion problems	Volume
	Mathematics 073	Computes	Multiplication	Whole numbers
	Mathematics 047	Computes	Division	Whole numbers
	OR			
	Mathematics 262	Uses calculator	Division	
	Mathematics 266	Uses calculator	Multiplication	
OBJECTIVE 13	Mathematics 232	Solves	Proportion problems	Volume
	Mathematics 261	Uses calculator	Addition	
	Mathematics 262	Uses calculator	Division	
	Mathematics 266	Uses calculator	Multiplication	
	Mathematics 124	Converts	Units	
	Mathematics 117	Converts	Formula	Equivalent form
	Mathematics 127	Converts	Word problems	Mathematical expressions

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 14	Language Arts 035	Attends	Directions/ task	
	Mathematics 232	Solves	Proportion problems	Volume
	Mathematics 185	Measures	Direct	Weight
	Mathematics 184	Measures	Direct	Volume

INFORMATION SHEET

PREPARING GROWING MEDIA

III

OBJECTIVE 1

List the major functions of a growing media.

A growing media must be easy for the grower to obtain, consistent in quality from one batch to the next and cost efficient. Once a media has been chosen the grower must be able to reproduce that media time after time. Premade media is generally very consistent in quality; a media blended at a greenhouse will be of consistent quality if a media recipe is accurately followed. In addition, the media must satisfy the major characteristics listed below.

- **Provide support**—A good media must be able to hold the plant or cutting upright in the pot.
- **Provide water**—A top quality media has the ability to hold large amounts of water, but will release the moisture to the plant when it needs it. The ability to hold large amounts of water is called water holding capacity.
- **Provide aeration**—Plant roots cannot survive without air. If a media drains well and has adequate pore space, gases and air can easily exchange at the root surface. This is called media porosity.
- **Provide nutrition**—A media must be able to retain nutrients required by the plant and then release them as needed. If a media is unable to hold nutrients, plants will not survive. Generally the nutrient holding capacity of a media is related to the water holding capacity.

OBJECTIVE 2

Match the major components of a growing media to their descriptions.

A greenhouse growing media is made by mixing several different components together. The type of media can be changed by adding various amounts of these components. For example, an all purpose growing media is usually 50-70% peat moss, but a cacti media may only have 25% peat. Each component has specific characteristics and performs certain functions in the growing media.

A brief discussion of the major components follows below.

- **Sphagnum peat moss**—Partially decomposed sphagnum moss. It has the highest water holding capacity of all moss, and yet it drains well. This is why sphagnum peat is used so often in growing media. The high water holding capacity and drainage ability is due to the stringy fiber texture of the moss. However, if peat is excessively shredded or over mixed the structure is destroyed and compaction of the media will result in reducing drainage. Sphagnum peat is naturally sterile due to its low pH, near 4.0, and is very slow to decompose. Other types of peat are available for use in a growing media but they are poorer in quality and produce an inferior media.

- **Field soil**—May or may not be part of a greenhouse growing media. If a media contains no field soil it is called a soilless media. If field soil is used in the media it is referred to as a soil based growing media. Growers who use field soil like the trace elements it provides to the growing media. If field soil is used it should be a loam type that drains well and is free of herbicide residue or chemical contamination. The soil must be available in a continuous supply and the quality has to be consistent. Many growers are having a difficult time finding a sufficient supply of good quality soil. Once the soil is obtained it must be prepared and pasteurized before it can be blended into a media. About one-half of the greenhouses in the United States use a growing media that contains a soil base and the other one-half use a soilless media.

- **Vermiculite**—Expanded pieces of mica mineral that can hold large amounts of water and nutrients. It is naturally high in potassium, lightweight, and sterile. Vermiculite can be easily compressed and because of this it is usually not used in soil based media. Vermiculite is stable and long lasting in soilless media.

  NOTE: Current research indicates the possibility of asbestos contamination.

- **Perlite**—Pieces of expanded lava rock that are used to provide aeration to a media. These particles are sterile and very lightweight. Fluoride is often a contaminant in perlite and may cause injury to fluoride sensitive plants. Washing the perlite before incorporating into a media will leach the fluoride and reduce injury. Employees should wear dust masks when handling perlite because the dust from this product can accumulate in their lungs and cause significant health problems.

- **Sand**—Is an excellent provider of aeration to a growing media, but it is extremely heavy - 100 pounds per cubic foot. Washed concrete grade sand is the best type to use in media. Sand must be pasteurized before use and it has very little water or nutrient holding capacity. It does provide weight to a soilless media and prevents the containers from falling over.

- **Bark**—Many different types can be used in growing media. Since bark is expensive to transport, growers generally use the type native to their area. The east and gulf coast states commonly use pine bark; fir bark is used on the west coast. Greenhouse growers previously had to partially decompose the bark before it could be used in a media, but today processed bark is available. Purchasing processed bark has eliminated this decomposition period. Fresh bark uses the nutrients in a growing media to feed its decomposition process; processed bark is very slow to decompose and does not tie up nutrients. Bark is available in various sizes; pieces 3/8 inch and smaller increase the water holding capacity of a media and larger pieces (3/8 - 3/4 inch) increase drainage and aeration.

- **Polystyrene beads**—Can be used in place of perlite to improve drainage and aeration. These beads are sterile, have no water holding capacity and do not affect the pH of the media. These beads have a tendency to float to the top of a growing container over a period of time. Particles less than 1/4 inch in diameter are best for media use.

  NOTE: This product may be difficult to obtain in the future due to the environmental movement to reduce plastic and styrofoam consumption.

- **Calcined clay**—A group of clay particles that have been heated to a high temperature and have become very hard. These pieces are of various sizes and shapes and when added to a growing media increase pore space and improve drainage. Calcined clay has a high nutrient and water holding capacity, is slow to decompose and adds weight to a media. This material should only make up 25-30% of a growing media. Kitty litter and auto mechanic's oil absorbent particles are types of calcined clay.

- **Plant by-products**—Are sometimes usable in growing media. They are generally used in parts of the country where they are produced. Be careful that they do not contain disease, pest or toxic chemicals that could be introduced into the media. Many of these types of organic matter decompose rapidly and will tie up the nutrients in the media. Extra nitrogen can be applied to account for the loss due to decomposition. These materials should be chopped, shredded and screened before pasteurization. Sawdust, rice hulls, straw and peanut hulls are examples of plant by-products that can be used in growing media. Pecan shells are not usable in a greenhouse medium due to the flat shape and sharp edges on each particle; they do make good mulch for outdoor beds.

  NOTE: A grower has unlimited choices when it comes to choosing media components as long as they meet the required characteristics for a growing media.

OBJECTIVE 3

Discuss choosing a growing media. (Supplements 1 and 2)

There are numerous types and kinds of growing media available on the market, and no media is right or wrong. The greenhouse grower should use a media they are comfortable and successful with. There are several items to consider before choosing a media.

- **What does the crop need?** Does it need a media that has lots of air space and is dry by nature, or does it need a media that stays moist most of the time? Is media weight important in crop production? Does the operation need several different media for different crops, or will one media work for all crops?

- **How much media is needed?** Premade media is economical for the small grower but may be too expensive for the larger greenhouses. Calculate the cost of mixing your own media and see which is cheaper. Do not forget to figure in the cost of labor when mixing your own media. Do you have the skilled labor to accurately mix the media? Supplement 1 lets you calculate how much media a crop will require. Use this chart to estimate your media needs for the year.

- **What type of media is the grower comfortable with?** Do they prefer a soil or soilless media? Is there a reliable source of field soil nearby?

- **Does the grower want convenience?** Premade media is easy to use and the quality is generally consistent. A lot of growers feel they don't have the time to spend blending media. Other growers cannot justify the expense of premade media.

  All media is made by combining at least two components. The amount of each component is expressed on a volume basis. For example, a 1:1 peat perlite medium is made by combining one volume of peat and one volume of perlite. It might be one bushel basket of peat and perlite, or one front end loader scoop of peat and perlite. Some of the most common media are:

1:1:1	peat, perlite and vermiculite
2:1:1	peat, perlite and vermiculite
3:1:1	peat, perlite and vermiculite
2:1:1	peat, field soil and perlite
1:1:1:1	peat, field soil, sand and perlite

Growers can put together any combination of components to make the media *they* want. However, media pH and other plant requirements must be satisfied and this will be discussed later.

Supplement 2 explains why field soil alone does not make a good growing media.

OBJECTIVE 4

Select from a list true statements about shredding and screening media components.

- Shredding and screening are generally done to reduce particle size and to make sure all particles are the same size. Field soil and plant by-products generally must be shredded and screened. Bales of peat moss can be placed in a shredder to loosen them from the compressed state.
  - To loosen bales of sphagnum peat, break them into chunks and drop into the shredder; only run peat through the shredder one time. Excessive shredding will destroy the fiber structure and cause the media to drain poorly.
  - If the component needs to be pasteurized, do it after the shredding and screening treatment.
  - Field soil should go through a shredder to break up the clods.
  - Plant by-products should be shredded into pieces about 1/2 inch in diameter.

- Screening is done to exclude particles over 3/4 inches in diameter.
- Most materials that are shredded should be screened immediately after shredding; peat moss should not be screened.
- Purchased components like perlite, vermiculite, calcined clay and polystyrene should not be shredded or screened.
- Electric or gasoline shredders are acceptable. Make sure the equipment is the proper size for the job. Don't try to shred material that is too big for the machine.
- Always wear safety goggles, dust mask, and exercise safety practices.
- Many growers blend media without the use of shredding or screening.

OBJECTIVE 5

Complete statements concerning proper pasteurization procedures.

- A growing media needs to be free of disease, insects and weeds if a crop is to survive.
- Anyone who uses field soil, sand or plant by-products in their media must pasteurize these components before mixing the media.
- If blending a soilless media there is no need to pasteurize; these components are pasteurized during the manufacturing process. Premade mixes are already pasteurized when they are purchased.

Pasteurization is a process that destroys harmful pathogens but does not affect desirable ones. A grower can use either heat or chemicals to pasteurize media components.

- **Heat**—This process requires heating the components to 180°F and holding it there for 30 minutes. Temperatures higher than 180°F kill helpful organisms and are not recommended.
    - Steam was commonly used years ago to pasteurize media. Unfortunately, the temperatures often exceeded 180°F and desirable organisms were killed. In recent years steam has been mixed with air and injected into the media. Aerated steam can be regulated to an accurate temperature and the air pressure ensures even pasteurization. However, few greenhouses have access to steam today and it is not a common method of pasteurization.
    - Electric sterilizers are specially designed units that are thermostatically controlled to heat components to a desired temperature. Since these machines only supply heat, the components should be moist when placed in the sterilizer. Heat causes the moisture to turn to steam and pasteurization is improved. These sterilizers can be purchased in various sizes ranging from one cubic foot up to one cubic yard. They are moderately priced and do a fair job of pasteurization.
    - Solar pasteurization has been tried by a few growers with limited success. The material to be pasteurized must be covered with plastic and exposed to solar radiation for several weeks.

      Frequent mixing of the component is needed to make sure all the material is completely pasteurized.
- **Chemicals**—Are generally used under outdoor conditions. These chemicals are liquids under pressure and when released they turn into gaseous fumes. These fumes penetrate into the media and kill all living organisms. The vapors are only active if the media temperature is 60° to 90°F.

For chemical pasteurization to effectively control pathogens the media or component must be worked up and in a loosened state, must be moist and less than 12 inches deep. The media or component must be covered with a leak proof cover, usually plastic, and then the chemical is released under the cover. These vapors have to remain sealed under the cover for 2-3 days. Once the cover has been removed the media or component must be aerated for 7-10 days. After the aeration period the media or component may be used.

Chemicals work well for the pasteurization of media; however, their use is time consuming and labor intensive. These chemicals are very hazardous to humans and extreme caution must be used when working near these chemicals. Methyl bromide and chloropicrin are the two most commonly used materials. These chemicals contain a small amount of tear gas in them as a warning device to the applicator. Tractor mounted rigs can automatically apply pasteurizing chemicals on large areas but smaller areas require direct human application.

WARNING: These are restricted use pesticides and the label directions must be strictly followed.

OBJECTIVE 6 **List the additives for a cubic yard of 3:1:1 peat:perlite: vermiculite soilless medium.**

- The large numbers of growing media available were discussed earlier in this unit. The actual amount of additives used in a media will depend on what the components are and their proportions. Each time a new combination of components is created the grower must experiment with the rate of additives needed. For this reason most growers find a media they like and stick with it.

  Regardless of what the media is composed of the growers usually:

  - Adjust the pH of the media to 5.5 - 6.2. Dolomitic limestone is generally used to adjust the pH. Dolomitic limestone is finely ground limestone and reacts quicker than agricultural limestone. It contains calcium and magnesium and has fewer contaminants than agricultural limestone.

  - Supply trace elements to the media. Since a soilless medium is composed of mainly inert components there are no natural trace elements available. Growers who use field soil in their growing media do so because it supplies adequate levels of trace elements and they don't have to add any trace elements.

  - Add a source of phosphorus. Soilless components lack natural phosphorus so the grower must provide it. Superphosphate is commonly used as the phosphorus source because it supplies calcium and sulfur along with phosphorus. Triple superphosphate is also a good source of phosphorus but it does not supply sulfur.

- Incorporate a wetting agent to help with the wetting and rewetting of the media. Generally, a granular material is preferred.

- Supply nitrogen and potassium at starter rates. All of the materials discussed above are added to the media in rates that will last about a year. The nitrogen and potassium incorporated will only last a few weeks and are only intended to get the plant started. A grower's fertility program should supply the correct nitrogen and potassium levels, not the media.

The list below gives the proper additives and rates for a cubic yard of 3:1:1 peat perlite vermiculite medium.

10 pounds dolomitic limestone
2.5 pounds superphosphate
1.5 pounds aqua-grow wetting agent
1.5 pounds potassium nitrate
1 pound micrc-max **or** 3 ounces of fritted trace elements (FTE 555)

Remember, if the proportions of components are altered or different components are used, the amount of additives will be different. When changing media, a grower should try mixing a small batch to make sure the ingredients are in the proper ranges and the media pH is correct before large volumes of media are blended.

OBJECTIVE 7 **Arrange in order the proper procedure for blending media.**

Every step in blending a media must be accurately carried out if the grower is to have consistent quality. Make sure that the person responsible for mixing media understands the procedure and knows how important accuracy is.

1. Determine the volume of media needed.

2. Calculate the volume of each component required to make the desired amount of media.

3. Calculate the amount of additives needed for the volume of media to be mixed.

4. Weigh out the additives and blend them together in a small bucket or container.

5. Place the correct volume of each component in the mixer or mixing area. Media can be blended with a shovel on a washed concrete floor, by hand on the potting bench, in a small concrete mixer, or in a soil mixer if large volumes are blended.

6. Begin blending and add water; the amount will vary with the volume of media being mixed. Use a hose with a pistol nozzle and spray the surface of the components as they are being mixed. Keep blending and continue to add water periodically until the desired moisture content is reached; a handful of components should stick together when squeezed but no water should drip out of the squeezed handful.
7. Mix the components for 3-4 minutes or until evenly blended. Do not over mix, especially in the cement mixer. Excessive mixing will destroy the particle structure and the media will drain poorly.
8. Add the additives by sprinkling over the blended component surface.
9. Mix again until the additives are well incorporated. This should only take 1-2 minutes in a cement mixer or several minutes longer if mixing by hand.
10. Place media on the potting bench or in the proper storage facility.

The biggest mistake made while blending media is over mixing. If the media is over mixed the strings of peat moss and vermiculite shatter and become small. This causes the media to be tight and drain poorly. Mix only long enough to evenly blend the components and additives.

OBJECTIVE 8

Describe incorporation of fertilizers into growing media.

Some growers prefer to incorporate fertilizer into the media. This is done to avoid liquid fertility programs while growing or to supplement a liquid program during production.

Slow release fertilizers are used in media feeding programs. These fertilizers become slowly available to the plant and last for a long time. A typical slow release fertilizer involves coating the fertilizer prills with water insoluble plastic. These prills absorb water and the fertilizer solution slowly leaks out into the media. A slow release fertility program is popular with growers because there is a constant source of nutrients available to the plant. Osmocote is a slow release fertilizer that lasts for 3 to 14 months depending on the formulation used.

A slow release fertilizer should be incorporated during the blending of a homemade media. Premade media can be placed in the mixing area, the fertilizer added, and then blended into media. To avoid this extra blending many growers will topdress with slow release fertilizers when using a premade media.

A topdress fertility program places a slow release fertilizer on the surface of the media in each growing container after potting. The same slow release fertilizers are used as in the incorporation method but the material sits on top of the media surface. As the pot is watered the fertilizer is released and the nutrients move downward through the media with the water. Caution should be used when watering so the slow release fertilizer is not washed out of the pot. Topdressing also requires an extra labor step but most growers feel the benefits of slow release fertilizers are worth it.

Make sure of the correct fertilizer rate when incorporating slow release fertilizer. Once the material is mixed into the media it cannot be removed; neither can the excess be leached out. Pay careful attention to the calculations and weighing procedures during incorporation.

OBJECTIVE 9

Identify methods of adjusting media pH.

The pH of a growing media will change over time due to the water source and fertilizer used. If the pH drifts too high or too low a grower must bring it back to the desired range. Several methods can be used to alter the pH.

- If the pH becomes too alkaline, reduce it by:
  - Injecting acid into the water before it is applied to the plant. Phosphoric or sulfuric acid are commonly used. Many fertilizer injectors are equipped to inject acid.
  - Use an acid reaction fertilizer.
  - Apply ground sulfur at a rate of 1-3 pounds per 100 square feet.
- If the pH becomes too acidic, increase it by:
  - Drenching with a lime solution. Make a supersaturated solution of quick lime and water in a container. Allow excess lime to settle to the bottom and then draw off the clear solution. Apply this solution to the media.
  - Apply finely ground calcium carbonate or dolomitic limestone at a rate of 5 pounds per 100 square feet.
  - Use an alkaline reaction fertilizer.

OBJECTIVE 10

Select from a list true statements concerning proper storage procedures for media.

- A growing media should be free of pathogens prior to use. Proper storage will protect unused media from external contamination.

  If the greenhouse is using premade media or sterile components:

  - Stack bags in a protected location away from wind and rain or waste contamination.
  - Raise the bags up off the floor. Stack the bags on a pallet or shelf to prevent them from absorbing moisture from the ground.
  - Torn bags should be taped shut. If the tear is too severe and not repairable, use those bags first.
  - Calculate the amount of media or components needed before opening or preparing materials. Unused components can usually be returned to the original containers and sealed shut.
  - Once a premade media has been loosened and moistened it will not fit in the original container. New plastic garbage cans with lids are good for storing small amounts of media. Larger volumes may be placed in a bin and covered with plastic or a tarpaulin. Any type of storage container that protects the media from contamination can be used. The storage container should not be air tight; the media will mold if it stays constantly moist.
  - Label the stored media, especially if fertilizers or other special ingredients have been added.

  If the grower is using homemade media:

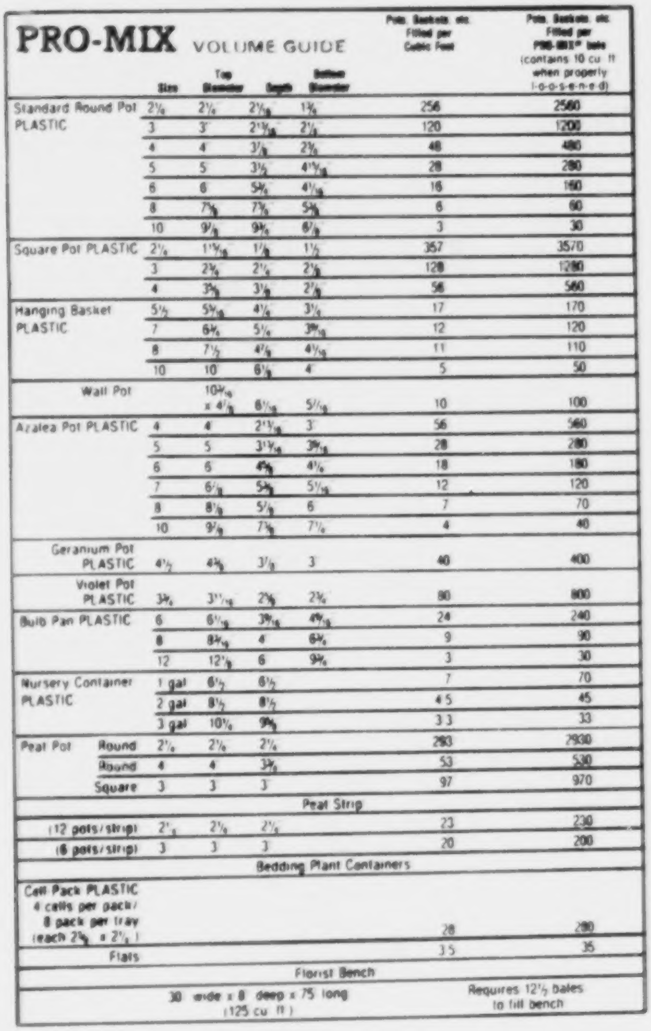
  - Mix the amount of media required. If the grower wants to blend some extra for the next crop, blend only what will be used in 30 days. Media will stay cleaner when stored for a short period of time.
  - Use caution when storing a media that has fertilizer incorporated in it. Slow release fertilizers begin to release nutrients as soon as they absorb moisture. Nutrients continue to be released during storage and could accumulate to toxic levels.

- Store excess homemade media the same way premade media is stored.
- Label for future use.

CAUTION: Media should not be stored in the vicinity of pesticides or herbicides.

APPROXIMATE MEDIA REQUIREMENTS FOR FILLING CONTAINERS

PRO-MIX VOLUME GUIDE



PRO-MIX VOLUME GUIDE

	Size	Top Diameter	Depth	Bottom Diameter	Pots, Baskets, etc. Filled per Cubic Foot	Pots, Baskets, etc. Filled per PRO-MIX® bale (contains 10 cu. ft. when properly l-o-o-s-e-n-e-d)
Standard Round Pot PLASTIC	2 1/4	2 1/4	2 3/16	1 3/4	256	2560
	3	3	2 13/16	2 1/8	120	1200
	4	4	3 7/8	2 3/4	48	480
	5	5	3 1/2	4 11/16	28	280
	6	6	5 3/4	4 1/16	16	160
	8	7 7/8	7 3/4	5 5/8	6	60
	10	9 7/8	9 3/4	6 7/8	3	30
Square Pot PLASTIC	2 1/4	1 15/16	1 7/8	1 1/2	357	3570
	3	2 3/4	2 1/4	2 1/8	128	1280
	4	3 5/8	3 1/8	2 7/8	56	560
Hanging Basket PLASTIC	5 1/2	5 9/16	4 1/4	3 1/4	17	170
	7	6 3/4	5 1/4	3 9/16	12	120
	8	7 1/2	4 7/8	4 1/16	11	110
	10	10	6 1/8	4	5	50
Wall Pot		10 3/16 x 4 7/8	6 1/16	5 1/16	10	100
Azalea Pot PLASTIC	4	4	2 13/16	3	56	560
	5	5	3 13/16	3 9/16	28	280
	6	6	4 5/8	4 1/4	18	180
	7	6 7/8	5 3/8	5 1/16	12	120
	8	8 1/8	5 7/8	6	7	70
	10	9 7/8	7 5/8	7 1/4	4	40
Geranium Pot PLASTIC	4 1/2	4 3/8	3 7/8	3	40	400
Violet Pot PLASTIC	3 3/4	3 11/16	2 5/8	2 3/4	80	800
Bulb Pan PLASTIC	6	6 1/16	3 9/16	4 9/16	24	240
	8	8 3/16	4	6 3/4	9	90
	12	12 1/8	6	9 3/4	3	30
Nursery Container PLASTIC	1 gal	6 1/2	6 1/2		7	70
	2 gal	8 1/2	8 1/2		4.5	45
	3 gal	10 1/4	9 5/8		3.3	33
Peat Pot Round	2 1/4	2 1/4	2 1/4		293	2930
Round	4	4	3 3/4		53	530
Square	3	3	3		97	970
Peat Strip						
(12 pots/strip)	2 1/4	2 1/4	2 1/4		23	230
(6 pots/strip)	3	3	3		20	200
Bedding Plant Containers						
Cell Pack PLASTIC 4 cells per pack/ 8 pack per tray (each 2 5/8 x 2 1/4)					28	280
Flats					3.5	35
Florist Bench						
30" wide x 8" deep x 75' long (125 cu. ft.)						Requires 12 1/2 bales to fill bench

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REASONS WHY FIELD SOIL ALONE DOES NOT MAKE A GOOD GROWING MEDIA.

- It is difficult to get field soil that is consistent in quality. In the field, soil located two feet apart can be dramatically different in structure and texture

- Field soil is very heavy

- Drainage is restricted when soil is placed in a container. Outdoors, field soil drains horizontally and vertically. When placed in a container the horizontal drainage is destroyed and the soil does not drain as efficiently.

- Shrink swell capacity of field soil in a container is subject to large fluctuation. When field soil in a container dries, it shrinks away from the edge of the pot and becomes very dense. This shrinking occurs every time the container dries, and porosity is reduced.

ASSIGNMENT SHEET 1

PREPARING GROWING MEDIA

III

NAME ______________________________ SCORE _______

OBJECTIVE 11 **Calculate the volume of media required.**

INTRODUCTION Objective 3 discusses the importance of the amount of growing media a greenhouse requires. A grower who uses large amounts of media usually blends his or her own. Sometimes a special media may be required and it will have to be blended at the greenhouse. Regardless of the reason, a grower must be able to estimate the amount of growing media he or she needs for the crop.

DIRECTIONS Use Supplement 1 to determine how much media will be required for the crop, or how many pots can be filled from a given volume of media.

1. How many cubic feet of media will be needed to pot 1200 rooted geranium cuttings into 4 1/2 inch geranium pots?

2. How many cubic feet of media will be needed to grow 250 poinsettias in 6" azalea pots?

3. How many 6" standard pots can be filled from 4.5 cubic feet of media?

4. How many cubic feet of growing media is needed to grow 75 10" impatiens hanging baskets and 30 7" petunia hanging baskets?

PREPARING GROWING MEDIA

NAME ______________________________ SCORE _______

OBJECTIVE 12

Calculate the volume of components required to blend a media.

INTRODUCTION

Objective 2 covers the basic components of a growing media and Objective 3 lists some of the most common mixes. It also states clearly that a greenhouse media is always calculated on a volume basis; a 2:1:1 medium is made of 2 parts peat, 1 part perlite and 1 part vermiculite. Recipes for growing media are usually given on a per cubic yard rate. Very few growers mix that much media at one time so they must calculate the rates for smaller batches of media. Since a cubic yard is equal to 27 cubic feet, a grower can determine the amount of components needed for any volume of media.

DIRECTIONS

Follow the example below to calculate the volume of components required to blend the given media.

EXAMPLE: How much peat and calcined clay is needed to blend a cubic yard of 2:1 peat clay medium?

Solution:

1 cubic yard = 27 cubic feet
2:1 peat:calcined clay medium is composed of 3 parts
27 cubic feet divided into 3 parts = 9 cubic feet/part

2 parts peat = 18 cubic feet peat
1 part calcined clay = 9 cubic feet calcined clay

1. How much peat, perlite, vermiculite and sand must be blended to make 10 cubic feet of a 2:1:1:1 peat:perlite:vermiculite: sand medium?

2. How much peat, perlite and vermiculite is needed to blend 14 cubic feet of a 3:1:1 peat:perlite:vermiculite growing medium?

3. How much peat, perlite, sand and field soil is needed to mix 3 cubic feet of a 3:2:1:1 peat:perlite:sand:field soil medium?

ASSIGNMENT SHEET 3

PREPARING GROWING MEDIA

III

NAME ______________________________ SCORE _______

OBJECTIVE 13 **Calculate the amount of additives required for a growing media.**

INTRODUCTION Objective 6 states that every growing media will require different amounts of additives. Once a grower finds a media they like they should stick with that combination. The additives and amounts given in Objective 6 are for a cubic yard of 3:1:1 peat:perlite:vermiculite medium. However, many growers will not need a cubic yard of media so they must calculate the amounts of additives necessary for a small volume of media. The activity on this assignment sheet emphasizes this area.

DIRECTIONS Follow the example below to calculate the amount of additives required for each growing media.

EXAMPLE: How much of each additive is required to blend 14 cubic feet of a 3:1:1 peat:perlite:vermiculite medium?

Solution:

1 cubic yard = 27 cubic feet
1 cubic yard of 3:1:1 media requires:
- 10 pounds dolomitic limestone
- 2.5 pounds superphosphate
- 1.5 pound Aqua-Gro
- 1.5 pound potassium nitrate
- 1 pound micro max

Since only 14 cubic feet are being blended

$$\frac{\text{10 pounds dolomite}}{\text{27 cubic feet}} = \frac{x}{\text{14 cubic feet}}$$

x = 5.2 pounds dolomitic limestone per 14 cubic feet.

$$\frac{\text{2.5 pounds super}}{\text{27 cubic feet}} = \frac{x}{\text{14 cubic feet}}$$

x = 1.3 superphosphate per 14 cubic feet

$$\frac{\text{1.5 pound Aqua-Gro}}{\text{27 cubic feet}} = \frac{x}{\text{14 cubic feet}}$$

x = .77 pounds Aqua-Gro per 14 cubic feet

$$\frac{1.5 \text{ pound potassium nitrate}}{27 \text{ cubic feet}} = \frac{x}{14 \text{ cubic feet}}$$

x = .77 pounds Aqua-Gro per 14 cubic feet

$$\frac{1.0 \text{ pound micro max}}{27 \text{ cubic feet}} = \frac{x}{14 \text{ cubic feet}}$$

x = .52 pounds micro max per 14 cubic feet

1. How much dolomite and potassium nitrate (13-0-44) is needed to make 6 cubic feet of the 3:1:1 medium? **If less than 1 pound convert the answer to ounces.**

2. How much micromax is need in 4 cubic feet of the 3:1:1 medium?

3. How much dolomite, superphosphate, wetting agent, potassium nitrate and FTE is needed to blend 30 cubic feet of the 3:1:1 medium? **If less than one pound, convert the answer to ounces.**

4. Convert your answer from question 3 to grams. The conversion factors necessary are:
    one ounce = 28.35 grams
    one pound = 453.6 grams

ASSIGNMENT ANSWERS

PREPARING GROWING MEDIA

III

ASSIGNMENT SHEET 1

1. 30
2. 13.88 = 14
3. 72
4. 17.5 = 18

ASSIGNMENT SHEET 2

1. 4 cf. peat, 2 perlite, 2 vermiculite, 2 sand
2. 8.4 cf. peat, 2.8 perlite, 2.8 vermiculite
3. 1.3 cf. peat, 0.9 perlite, 0.4 sand, 0.4 field soil

ASSIGNMENT SHEET 3

1. 2.2 lbs dolomite, 5.3 ozs 13-0-44
2. 2.4 ozs micromax
3.

dolomite	11.1 lbs
0-20-0	2.8 lbs
wetting agent	1.7 lbss
13-0-44	1.7 lbs
FTE	3.3 ozs

4.

dolomite	5034.96 gms
0-20-0	1270.08 gms
wetting agent	771.12 gms
13-0-44	771.12 gms
FTE	93.55 gms

JOB SHEET 1

PREPARING GROWING MEDIA

III

OBJECTIVE 14

Demonstrate the ability to blend a growing media.

INTRODUCTION

Blending a growing media requires the knowledge of components and additives and the ability to calculate the amount of each material needed. The following procedure requires the practical application of both.

EQUIPMENT AND SUPPLIES

- One cubic foot box
- Peat, perlite and vermiculite
- Dolomite, 0-20-0, wetting agent, 13-0-44, and micro-max
- Gram scale
- Concrete mixer, clean floor or potting area
- Water hose with pistol spray nozzle

PROCEDURE

1. Calculate how much peat, perlite and vermiculite is needed to blend 2.5 cubic feet of 3:1:1 medium.
2. Calculate the amount (in grams) of dolomite, 0-20-0, wetting agent, 13-0-44, and micromax needed for the 2.5 cubic feet of medium.
3. Weigh out all the additives and blend them together in a small bucket or container.
4. Measure out the correct volume of peat, perlite and vermiculite. While blending add water until the medium is at the correct moisture level.
5. Add the additives and blend until uniformly mixed. Remember, do not mix any longer than necessary.
6. Store the media in a proper container until ready to use.
7. Clean up the cement mixer, potting area or floor where the mixing was done and put away equipment and supplies.

PRACTICAL TEST 1

PREPARING GROWING MEDIA III

JOB SHEET 1

Demonstrate the ability to blend a growing media.

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Calculated how much peat, perlite and vermiculite is needed to blend 2.5 cubic feet of 3:1:1 medium.	_____	_____
2. Calculated the amount (in grams) of dolomite, 0-20-0, wetting agent, 13-0-44, and micromax needed for the 2.5 cubic feet of medium.	_____	_____
3. Weighed out all the additives and blended them together in a small bucket or container.	_____	_____
4. Measured out the correct volume of peat, perlite and vermiculite. While blending added water until the medium was at the correct moisture level.	_____	_____
5. Added the additives and blended until uniformly mixed.	_____	_____
6. Stored the media in a proper container.	_____	_____
7. Cleaned up the cement mixer, potting area or floor where the mixing was done and put away equipment and supplies.	_____	_____

EVALUATOR'S COMMENTS

____

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key). A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Uniformly mixed media	4	3	2	1
Correct amounts of components and additives	4	3	2	1
Correct moisture level	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training
3 - Moderately skilled—Has performed job during training program; limited additional training may be required
2 - Limited skill—Has performed job during training program; additional training is required to develop skill
1 - Unskilled—Is familiar with process; but is unable to perform job

PREPARING GROWING MEDIA

NAME ______________________________ SCORE ________

OBJECTIVE 1

List the major functions of a growing media.

____

____

____

____

OBJECTIVE 2

Match the major components of a growing media to their descriptions. Write the correct letters in the blanks.

____ 1. Should be a loam type, and free of herbicide or chemical contamination.

____ 2. Expanded pieces of mica mineral that supplies potassium to a growing media.

____ 3. Has the highest water holding capacity of any moss and a pH near 4.0.

____ 4. An excellent provider of aeration; concrete grade should be used.

____ 5. Expanded lava rock that is often contaminated with fluoride.

____ 6. Is available in various sizes depending on your need and should be purchased in the processed form.

____ 7. Hardened pieces of soil that have high water and nutrient holding capacity, and increase the pore space of a media.

____ 8. Particles that provide aeration and improve drainage but tend to float to the media surface.

____ 9. Rice hulls, straw, and sawdust are examples of this type of component.

a. Bark
b. Calcined clay
c. Field soil
d. Mulch
e. Perlite
f. Plant by-products
g. Polystyrene beads
h. Premade media
i. Root media
j. Sand
k. Soilless media
l. Sphagnum peat moss
m. Vermiculite

OBJECTIVE 3

Discuss choosing a growing media. Answer the following questions in a brief manner.

1. How does the size of a greenhouse affect the choice of buying premade media or mixing your own media?

____

____

____

____

____

2. Does the type of crops grown affect the media selection? Explain why.

____

____

____

____

OBJECTIVE 4

Select from a list true statements about shredding and screening media components. Write an "X" in the blank before each true statement.

____ 1. If a component needs to be pasteurized it should be pasteurized before it is shredded.

____ 2. Gasoline or electric shredders are acceptable for greenhouse use.

____ 3. Perlite and polystyrene need not be shredded or screened.

____ 4. Calcined clay should be shredded.

____ 5. Goggles should be worn while operating a shredder.

____ 6. Compressed bales of peat can be loosened by putting them through a shredder.

____ 7. Screening is done to remove any particles larger than 1/4 inch.

____ 8. Peat moss needs to be screened.

OBJECTIVE 5

Complete statements concerning proper pasteurization procedures. Write the missing word in the blank.

1. Media components should be pasteurized ________________ mixing the media.
2. Field soil, ________________ and plant by-products should be pasteurized.
3. If a grower blends their own media using only ___________ components, pasteurization is not necessary.
4. Pasteurization is a process that destroys harmful _________ but does not affect desirable ones.
5. The two kinds of processes used to pasteurize media are ____________________ and ____________________.
6. To properly pasteurize media components they should be heated to ___________ degrees for _____________ minutes.
7. When using an electric soil sterilizer, the media components must be ____________ when placed in the sterilizer.
8. Chemicals used for pasteurization change into ___________ when released from the container.
9. When pasteurizing media with chemicals a _____________ must be placed over the media and the chemicals are left in place for 2-3 days.
10. After chemical pasteurization the media must be _________ for 7-10 days before it can be used.
11. Chemicals used for pasteurization purposes contain ____________________ as a warning agent to the applicator.

OBJECTIVE 6

List the additives for a cubic yard of 3:1:1 peat:perlite: vermiculite soilless medium.

____

____

____

____

____

OBJECTIVE 7

Arrange in order the proper procedure for blending media.
Write a "1" in front of the first step, a "2" in front of the second, and so on.

____Add the additives by sprinkling over the blended component surface.

____Determine the volume of media needed.

____Add water.

____Mix the components for 3-4 minutes or until evenly blended.

____Calculate the volume of each component required.

____Weigh out the additives and blend them together in a small bucket or container.

____Place the correct volume of each component in the mixer or mixing area.

____Place media on potting bench or in proper storage facility.

____Calculate the amount of additives needed for the volume of media to be mixed.

____Mix again until the additives are well incorporated.

OBJECTIVE 8

Describe incorporation of fertilizers into growing media.
Briefly describe the following.

1. A slow release fertilizer

____

____

____

____

____

____

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2. Topdressing with fertilizer

3. How would you incorporate osmocote into a homemade media?

4. If a mistake is made during the weighing of a slow release fertilizer and too much is incorporated into the media, how can you remove the fertilizer?

OBJECTIVE 9

Identify methods of adjusting media pH. Write an "I" in the blank before the statements that increase media pH or a "D" in the blank before the statements that decrease media pH.

____ 1. Applying ground sulfur

____ 2. Using an acid reaction fertilizer

____ 3. Using an alkaline reaction fertilizer

____ 4. Drenching with a lime solution

____ 5. Injecting sulfuric acid into the water

____ 6. Applying finely ground calcium carbonate

OBJECTIVE 10

Select from a list true statements concerning proper storage procedures for media. Write an "X" in the blank before each true statement.

____ 1. Premade media can be stored outside of the greenhouse on the ground.

____ 2. Torn bags of media or components should be taped shut to keep the material clean.

____ 3. Stacking bags of media or components is harmful due to heat build up.

____ 4. Unopened bags of media or components should be protected from the wind and rain or waste contamination.

____ 5. Bags should be raised off the ground or floor to prevent them from absorbing moisture.

____ 6. Only open and prepare the amount of media or components needed.

____ 7. Prepared media should be stored in an air tight container.

____ 8. New garbage cans that have lids are good containers to store small amounts of prepared media.

____ 9. There is no need to label stored media.

____ 10. A prepared media that has slow release fertilizer incorporated continues to release nutrients while in storage.

NOTICE	The following assignment sheets and job sheet are not part of the written test. If these activities have not been completed, check with your instructor.	
OBJECTIVE 11	**Calculate the volume of media required.**	SCORE ________
OBJECTIVE 12	**Calculate the volume of components required to blend a media.**	SCORE ________
OBJECTIVE 13	**Calculate the amount of additives required for a growing media.**	SCORE ________
OBJECTIVE 14	**Demonstrate the ability to blend a growing media.**	RATING _______

WRITTEN TEST ANSWERS

PREPARING GROWING MEDIA

III

OBJECTIVE 1

Answer should include the following:

- Provide support
- Provide water
- Provide aeration
- Provide nutrition

OBJECTIVE 2

1. c
2. m
3. l
4. j
5. e
6. a
7. b
8. g
9. f

OBJECTIVE 3

1. Small greenhouses use less media and generally buy premade media. It also requires less labor. Large greenhouses use lots of media and find it cheaper to blend their own.
2. Yes. If a plant needs a lot of moisture the media will need to have large amounts of peat. If the plant needs dry conditions the media will have a lot of sand or perlite.

OBJECTIVE 4

2, 3, 5, 6,

OBJECTIVE 5

1. Before
2. Sand
3. Soilless
4. Pathogens or organisms
5. Heat, chemical
6. 180° F, 30
7. Moist
8. Vapors or fumes

9. Leak proof cover
10. Aerated
11. Tear gas

OBJECTIVE 6

Answer should include the following:

- Dolomitic limestone
- Superphosphate or triple superphosphate
- Wetting agent
- Potassium nitrate
- Micro-max or fritted trace elements

OBJECTIVE 7

8, 1, 6, 7, 2, 4, 5, 10, 3, 9

OBJECTIVE 8

1. A fertilizer that releases slowly and lasts a long time.
2. Placing slow release fertilizer on top of the media in a growing container after it has been potted.
3. Incorporate at blending time.
4. It cannot be removed.

OBJECTIVE 9

1. D
2. D
3. I
4. I
5. D
6. I

OBJECTIVE 10

2, 4, 5, 6, 8, 10

OBJECTIVES 11-13

Refer to answers to Assignment Sheets 1 through 3.

OBJECTIVE 14

Refer to Practical Test for Job Sheet 1.

OBJECTIVE SHEET

PROPAGATING PLANTS IV

INTRODUCTION

Most greenhouse growers try to produce the highest quality crops possible. The success of the finished crop depends largely on the quality of the plants produced during propagation. The majority of crops grown at any greenhouse will be propagated on site, so the greenhouse staff must be familiar with correct propagation procedures.

UNIT OBJECTIVE

After completing this unit, the student should be able to correctly and successfully propagate plants using various propagation techniques. The student will demonstrate these competencies by completing the assignment sheets, job sheets and written test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with propagation to their correct definitions.
2. Discuss propagation benches..
3. Complete statements about selecting propagation containers.
4. Select from a list true statements about seed varieties and calculating planting schedules.
5. Discuss germination media and seed sowing methods.
6. Arrange in order the stages of seed germination.
7. Describe the proper method for transplanting seedlings.
8. Select from a list true statements about preparing seed for storage.
9. Complete statements about producing and maintaining stock plants for asexual propagation.
10. Discuss preparing to harvest cuttings.
11. Describe the proper procedure for harvesting cuttings.
12. Discuss applying root promoting chemicals.
13. Discuss sticking cuttings.
14. Discuss transplanting rooted cuttings.
15. Discuss labeling plants during propagation.

16. Discuss the propagation of microcuttings.
17. Discuss propagation by division.
18. Select from a list true statements about propagation by layering.
19. Design a propagation bench. (Assignment Sheet 1)
20. Determine the correct conditions for seed germination. (Assignment Sheet 2)
21. Demonstrate the ability to
    a. Produce a crop from seed. (Job Sheet 1)
    b. Produce plants from stem tip cuttings. (Job Sheet 2)
    c. Produce plants from leaf bud cuttings. (Job Sheet 3)
    d. Produce plants using division techniques. (Job Sheet 4)

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SUGGESTED ACTIVITIES

PROPAGATING PLANTS

IV

PREPARATION

- Obtain materials to supplement unit.

  NOTE: See Suggested Resources.

- Review instructional outline for this unit. Modify time frames to suit class needs and plan activities for each class period.
- Study the specific objectives to determine those you will cover in your presentation. Decide also which objectives should be taught to which students.
- Determine scope and sequence of objectives that you add. Design and develop support materials, including evaluation techniques, for additional objectives.
- Determine how you will schedule time for students to demonstrate competence in the required procedures.
- Make arrangements for guest speakers. Supply speakers with specific objectives and other appropriate sections of the unit.
- Make arrangements to tour local greenhouses.

DELIVERY

Objective 1

- Introduce the topic of propagating plants. Discuss the importance of knowing how to properly propagate plants.
- Discuss terms associated with propagation.

Objectives 2 and 3

- Discuss propagation benches. Tour a greenhouse and discuss the parts of the propagation bench and explain the function of each part.
- Discuss propagation containers.
- Display common propagation containers and discuss the pros and cons of each container.

Objectives 4 through 8

- Discuss selecting seed varieties and calculating planting schedules.
- Discuss germination media and seed sowing methods.
- Discuss the stages of seed germination.
- Prepare samples of germination media for students to see and explain the difference between germination and growing media.
- Demonstrate in class how to sow seeds and discuss the germination process.
- Discuss the proper method for transplanting seedlings.
- Discuss preparing seed for storage.

Objectives 9 through 12

- Discuss producing and maintaining stock plants for asexual propagation.
- Discuss preparing for cutting harvest.
- Discuss the proper procedure for harvesting cuttings.
- Discuss applying root promoting chemicals.
- Demonstrate to students how to take cuttings and apply root promoting chemicals.

Objectives 13 through 15

- Discuss sticking cuttings.
- Discuss transplanting rooted cuttings.
- Demonstrate to students how to stick cuttings and transplant rooted cuttings.
- Discuss labeling plants during propagation. Show students examples of labeling.

Objectives 16 through 18

- Discuss the propagation of microcuttings.
- Discuss propagation by division.

- Discuss propagation by layering.
- Demonstrate to students how to divide and layer parent plants.

APPLICATION

Objective 19

- Use Assignment Sheet 1 to give students practice in designing a propagation bench.

Objective 20

- Use Assignment Sheet 2 to give students practice in determining germination and cultural requirements for a seeded crop.

Objective 21

- Use Job Sheet 1 to allow students an opportunity to produce a crop from seed.
- Use Job Sheet 2 to allow students an opportunity to produce plants from stem tip cuttings.
- Use Job Sheet 3 to allow students an opportunity to produce plants from leaf bud cuttings.
- Use Job Sheet 4 to allow students an opportunity to produce plants using division techniques.

EVALUATION

Practical test

- Explain to students that they will be asked to demonstrate procedures on the job sheets to complete the practical test.
- Describe the rating scale used on the practical test.
- Give practical test.
- Reteach and retest as necessary.

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Written test

- Explain to students that they will be asked to demonstrate on the written test actions listed in the specific objectives.

- Give written test.

  NOTE: Written test may be given in sections if desired.

- Evaluate students on assignment sheet activities if not previously done.

- Reteach and retest if necessary.

- Complete appropriate section of competency profiles.

- Review individual and group performance in order to evaluate teaching methods. Adjust scope, sequence, or instructional approaches for additional lessons as required.

SUGGESTED RESOURCES

Audiovisual Materials

- *Plant Propagation I and II*, 1/2" video, color, 40 min., Vocational Ed. Productions, 1987. Available from Vocational Ed. Productions, State University, San Luis Obispo, CA 93407-9990. This film covers four parts of plant propagation and three types of vegetative propagation.

  NOTE: This video is available to Oklahoma teachers on a free-loan basis. Oklahoma teachers may order this video from the Oklahoma Department of Vocational and Technical Education, Resource Center, ATTN: Instructional Media Specialist, 1500 W. Seventh Avenue, Stillwater, OK 74074, 1-800-522-5810. Out-of-state teachers must order from the address listed with the video.

Publications

- Ball Seed Catalog
  P.O. Box 335
  West Chicago, IL 60185
  (312) 231-3500

- Burpee Catalog
  300 Park Avenue
  Warminster, PA 18974
  1-800-999-8552

- Park Seed Catalog
  Cokesbury Road
  Greenwood, SC 29647-0001
  1-800-845-3366

Other Media

- Purchase a large size seed for students to do a seeding experiment. Dahlia, zinnia or marigold will work well.
- Grow stock plants for students to harvest cuttings from. They will need stock for stem tip cuttings (geranium, poinsettia, coleus, etc.) and stock for leaf bud cuttings (pothos).
- Order germination media, propagation containers and other necessary supplies for propagation.

UNIT REFERENCES

- *Ball Seed Catalog*. Geo. J. Ball, Inc., West Chicago, Illinois, 1989.
- Ecke, Paul, Jr., *Ecke's Poinsettia Manual*, Paul Ecke Poinsettias, Encinitas, California, 1976.
- Fretz, Thomas, P.E. Read and M.C. Peele, *Plant Propagation Lab Manual*, 3rd. ed. Burgess Publishing Co., Minneapolis, Minnesota, 1979.
- Halfacre, R. Gordon and John A Barden, *Horticulture*, McGraw-Hill Book Company, New York, New York, 1979.
- Hartman, Hudson T. and Dale E. Kester, *Plant Propagation Principles and Practices*, 4th ed., Prentice Hall Inc., Englewood Cliffs, New Jersey, 1983.
- Mastalerz, J.W. and E. Jay Holcomb, *Bedding Plants III*, Pennsylvania Flower Growers, 1985.
- Reilly, Ann. *Park's Success with Seeds*, Geo. W. Park Seed Co., Inc., Greenwood, South Carolina, 1978.
- Tobey, Peter, *Pirating Plants*, Tobey Publishing Co., Inc., New Canaan, Connecticut, 1975.

BASIC ACADEMIC SKILLS

The following table identifies the basic academic skills that are reinforced in this unit of instruction. These basic academic skills were identified using *The Basic/Essential Skills Taxonomy*, 2nd edition, and verified during the validation process.

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 1	Language Arts 013	Applies/Uses	Definitions	
	Science 466	Identifies	Definitions	
OBJECTIVE 2	Language Arts 132	Comprehends	Information-written	
	Language Arts 038	Collects/ Organizes	Information-oral/written	
OBJECTIVE 3	Language Arts 139	Comprehends	Information-written	Context
OBJECTIVE 4	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity
	Free Enterprise 118	Identifies	Cost factors	
OBJECTIVE 5	Language Arts 132	Comprehends	Information-written	
	Language Arts 038	Collects/ Organizes	Information-oral/written	
	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 6	Mathematics 254	Understands	Order of operation	Rules
OBJECTIVE 7	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
	Mathematics 254	Understands	Order of operation	Rules
OBJECTIVE 8	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity
OBJECTIVE 9	Science 385	Describes/ Explains	Plants	Propagation
	Language Arts 139	Comprehends	Information-written	Context
OBJECTIVE 10	Science 385	Describes/ Explains	Plants	Propagation
	Language Arts 098	Composes/ Edits	Reports/ essays	Summaries
	Mathematics 254	Understands	Order of operation	Rules
OBJECTIVE 11	Language Arts 098	Composes/ Edits	Reports/ essays	Summaries
	Mathematics 254	Understands	Order of operation	Rules

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 12	Language Arts 098	Composes/ Edits	Reports/ essays	Summaries
	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
OBJECTIVE 13	Language Arts 132	Comprehends	Information-written	
	Language Arts 038	Collects/ Organizes	Information-oral/written	
	Mathematics 254	Understands	Order of operation	Rules
OBJECTIVE 14	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
OBJECTIVE 15	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
OBJECTIVE 16	Science 385	Describes/ Explains	Plants	Propagation
	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
OBJECTIVE 17	Science 385	Describes/ Explains	Plants	Propagation
	Language Arts 013	Applies/Uses	Definitions	
	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 18	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity
OBJECTIVE 19	Science 337	Describes/ Explains	Matter	
OBJECTIVE 20	Science 385	Describes/ Explains	Plants	Propagation
	Mathematics 034	Computes	Addition	Whole numbers
	Mathematics 073	Computes	Multiplication	Whole numbers
	Mathematics 047	Computes	Division	Whole numbers
	OR			
	Mathematics 261	Uses calculator	Addition	
	Mathematics 262	Uses calculator	Division	
	Mathematics 266	Uses calculator	Multiplication	
	Language Arts 272	Uses	Library resources	

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 21a-d	Language Arts 035	Attends	Directions/ task	
	Language Arts 013	Applies/Uses	Definitions	

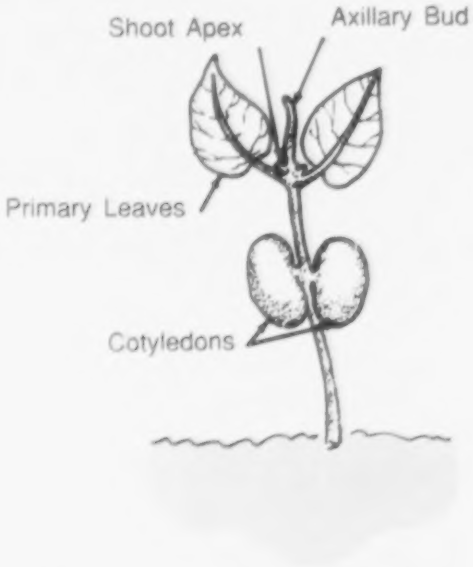
INFORMATION SHEET

PROPAGATING PLANTS IV

OBJECTIVE 1

Match terms associated with propagation to their correct definitions.

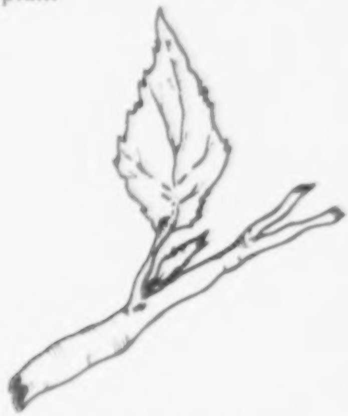
- **Asexual propagation**—A method of propagation that uses vegetative tissue to produce new plants
- **Callus**—Mass of undifferentiated cells that form near the wound on a cutting
- **Cotyledon**—The first leaf to emerge during germination; often called a seed leaf because it is part of the embryo inside a seed



- **Cutting**—A piece of vegetative plant tissue that when treated properly will regenerate a new plant
- **Division**—A method of propagation where the parent plant is divided into sections and each section becomes a new plant

- **Leaf cutting**—A method of propagation that uses a leaf blade or leaf blade and petiole to produce a new plant

- **Leaf bud cutting**—A method of propagation that uses a section of the plant stem with a leaf and axillary bud to produce a new plant



Leaf Bud Cutting

- **Microcutting**—Tiny stem tip cuttings that are produced through tissue culture techniques; these plants are usually less than one and a half inches tall and must be rooted before being put in the greenhouse

- **Mist nozzle**—A spray nozzle designed to produce a fine mist of water used for propagation

- **Plant propagation**—Increasing the numbers of a plant through reproductive techniques used by greenhouse growers

- **Propagation bench**—A bench specifically designed to supply mist and heat for propagation purposes

- **Seed**—An embryo that has a stored food supply and is protected by a seed coat

- **Seedling**—A new plant that emerges due to germination

- **Separation**—A method of propagation that involves removing newly formed plants from the parent plant

- **Sexual propagation**—A method of propagation that uses seeds to produce new plants

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- **Stem tip cuttings**—A method of propagation that uses a section of the stem that contains the growing point and lateral buds to produce new plants

- **True leaves**—Leaves that are initiated by a seedling plant; they are the leaves that appear after the cotyledons have emerged and are typical of the species

OBJECTIVE 2

Discuss propagation benches.

Just about every greenhouse propagates plants at some time, and many greenhouses have year round propagation schedules. A well planned propagation bench will provide the proper environmental conditions for any method of propagation and will be trouble free. It is important to carefully plan a propagation bench before construction so problems can be eliminated or special needs fulfilled.

The function of a propagation bench is to provide moisture so plants do not dehydrate, and warmth for quicker rooting or germination. Keep in mind that not all plants require the same amount of moisture or temperature. The following factors should be considered when planning a propagation bench.

- **Size**—This depends on how much propagating the greenhouse does. A small greenhouse that only germinates seeds in the spring might only need 20 square feet of propagation area, but a large greenhouse that propagates year round might need 3000 square feet of propagation bench. Calculate how much propagating is done at the greenhouse now, and then estimate how much will be done in the next 2-3 years. Only after calculating these numbers can you determine your propagation bench requirements.

- **Location**—This too depends on the size of the propagation bench. Small benches can be placed in an existing greenhouse, usually in the corner or off to one side. Remember, it is sometimes difficult to grow a crop and propagate plants side by side; the mist from the propagation bench may drift onto the crop, and high humidity levels in the propagation area may also cause disease problems. Temperatures or desired light intensities may not be compatible for both crops. These problems can usually be solved with a little ingenuity, but they should be planned for.

  A greenhouse that needs large amounts of propagation space usually groups the benches together in one house, or a special house is built for propagation purposes. It is easier and cheaper to maintain a propagating environment in one house than in parts of several different houses.

- **How should I build the propagation bench?** There are many ways to build a propagation bench. A grower can build a bench using any design or technique he or she chooses. There are a few rules that should be followed.

  - Benches should be no wider than six feet. If wider than this it is difficult for employees to reach the center of the bench.

  - Have the bench at a comfortable working height. When propagators have to stoop to stick cuttings their efficiency will be lowered.

  - Make sure the bench framing material will hold up under constant moisture. If wood is used as the frame it must be CCA pressure treated and should be painted. Because of this many growers use galvanized metal for the frame.

  - The bench should be easy to clean and sterilize. Diseases will thrive in a propagation area due to high humidity and warm temperatures. Frequent cleaning and sterilizing will be necessary to control the problem.

  - Excess moisture must quickly drain from the propagation bench. Usually some type of small gauge wire is used as the bench surface. This material works well because excess water falls to the floor and air circulates around the plants reducing disease.

- **How should I supply heat to the propagation bench?** The size of the bench will dictate what heating method is used. Listed below are the three most commonly used heat sources.

  - Propagation mats - Waterproof rubber mats that have heating wires embedded in the layers of rubber. An external thermostat is connected to the mat to control the temperatures. These mats can be laid on any bench surface and plugged into an electrical outlet. They are small (22" x 60") and work well for propagation areas that have limited use. These mats are expensive and are not feasible for heating large propagation areas.

  - Root zone heating - Tubes are placed directly on the surface of the propagation bench, on the floor or under the floor, and hot water is circulated through the tubes. The propagation containers are set on the tubes and the heat warms the media; propagation time is reduced by 20-40%. This system is long lasting and relatively trouble free once it is installed. It is economical for large sized propagation areas that are used constantly.

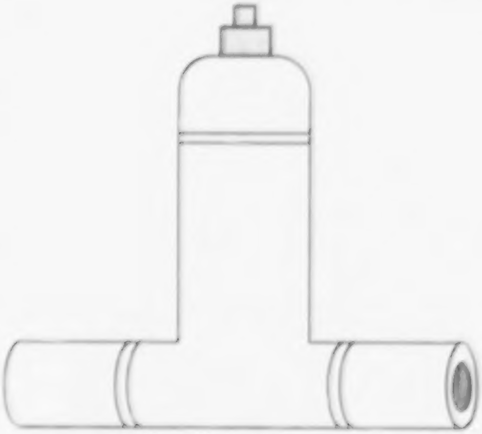
  - Under bench forced air heating - Hot air is blown under the propagation bench through a jet tube. A special unit heater is installed near the propagation bench at bench height and a blower forces the heat under the bench. The hot air rises from the tube and warms the media and air near the plants. One problem with this method is that it rapidly evaporates the mist and causes excessive drying. Increasing the mist frequency will usually eliminate this problem. The under bench forced air heat is cheaper initially than root zone heating but it requires more maintenance than does root zone heating.

- **What mist nozzle should I use?** There are many nozzles available from horticultural suppliers and each one is different. A sales representative can provide the technical information and answer any questions you may have. A good nozzle should:
  - Be easy to clean—Lime deposits will accumulate on the nozzle and must be removed frequently. Most nozzles are made of brass or plastic, and both clean easily.
  - Be easy to get replacement parts—Deflector pins will become worn over time and produce uneven spray patterns. Once this occurs the deflector must be replaced.
  - Produce a fine spray pattern—Large, heavy sprays leach nutrients from the leaves and cause the media to become waterlogged. A fine spray will keep the foliage wet and prevent drying but will not leach the foliage or saturate the media. Nozzles are sold according to the volume of water they put out on a per hour basis; an 8-10 gallon per hour nozzle is a typical mist nozzle.
  - Be easy to install—Some nozzles must have adapters before they can be placed in the header pipes; others only need to be taped before being placed in the pipe. Make sure all required parts and accessories are purchased when the nozzles are ordered.

- **How should I support the nozzles?** Nozzles must be mounted in a water line that runs the length of the propagation bench. There are two ways to place the water line; one is to suspend it above the propagation bench, and the other is to run it down the center of the bench.

When the water line is placed above the bench the nozzles should be installed facing downward. By putting the water line overhead no bench space is lost to the pipe so the entire surface can be used for propagation purposes. However, it is critical that the overhead water line be completely level. If it sags the nozzles near the low spot will constantly drip water and the plants below will become waterlogged and die.

When the water line is placed down the center of the bench it may be put on top of the bench surface or underneath the bench. If the water line is placed on top of the bench it takes up space and reduces the area available for propagation. However it is easy to repair if there is a problem or leak. Risers are installed in the water line and the nozzles are connected to the risers. A riser should be tall enough so the nozzle is above the cuttings. A riser 10-12 inches tall is standard height. When installing risers make sure they are perpendicular to the water line. If they are leaning the mist pattern will be uneven and poor rooting will result.



- **How far apart should the nozzles be spaced?** Place them close enough together so the mist patterns overlap. Any spot on the mist bench that does not get mist will not root cuttings. Each nozzle will give a suggested installation spacing; usually 3-4 foot centers.

- **What will keep the nozzles from becoming clogged?** An inline strainer should be installed in the water line before the water reaches the solenoid valve. The strainer will keep sand and dirt from entering the water line and will prevent the nozzles from clogging. The strainer also stops abrasion and wearing of the solenoid valve. Purchase a strainer that has a flush plug; this allows the screen to be cleaned without removing the strainer from the line. This piece of equipment is the best insurance policy you can buy to prevent clogged nozzles and worn parts.

- **What should I use to control the mist operation?** The mist on a propagation bench is needed on an intermittent basis. Most people use time clocks to operate the mist, and they work well. Two clocks will be required; a 24 hour clock to control day-night operation and a cyclic timer that activates the solenoid valve which controls the on-off cycle of the mist.

  An intermittent mist cycle is used to provide moisture to the cuttings and prevent them from drying out. Ideally there should be a slight film of water on the cuttings at all times until they are rooted. Cyclic timers have pre-set intermittent settings and this limits the growers choices on mist intervals. Newer solid state controllers offer the grower more flexibility in mist settings, but they are more expensive. The 24 hour clock can be used to turn the system on just before dawn and shut it off after dark. The clock can be adjusted to operate 24 hours a day if desired.

  A solenoid is a magnetic valve that lets water enter the water line on the mist bench. When the cyclic timer sends electricity to the solenoid valve it opens and water enters. When the cyclic timer shuts off electricity is no longer going to the solenoid valve so it closes and water cannot enter the system. Solenoids operate on 24 volt electricity so a transformer must be installed between the timer and the solenoid.

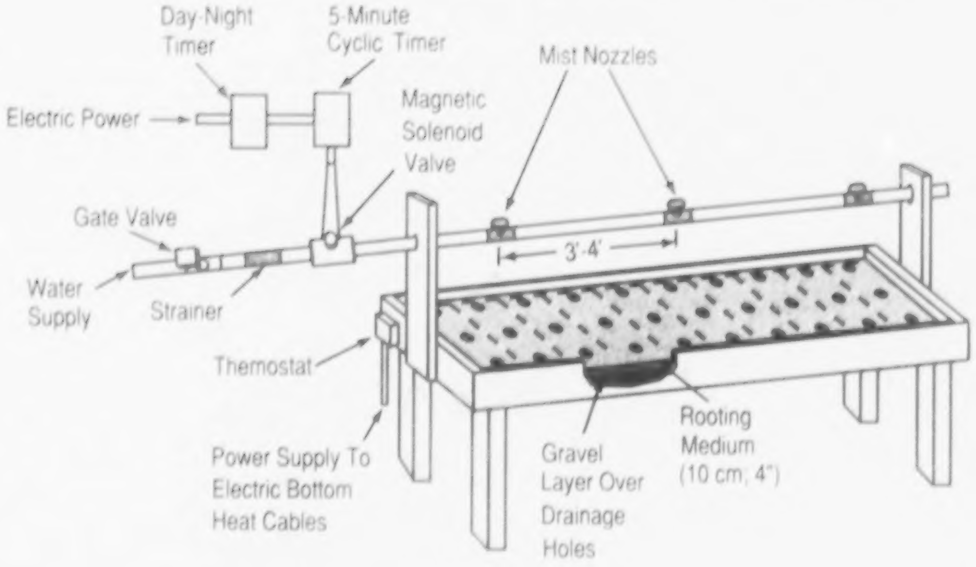
- **Will this system be dangerous to employees since electricity is used in the presence of water?** The solenoid valve operates on 24 volts of current so the bench is safe for employees; this weak current will not harm people. However, make sure the transformer is correctly installed so the current is reduced from 110 volt to 24 volt.

- **Should one cyclic timer be used to control the entire bench or should the bench be divided up into several sections?** When only one cyclic timer is used the entire propagation bench will operate as one unit. If there are fresh cuttings at one end of the bench and older cuttings at the other end of the bench the grower has a problem. When the mist is adjusted to suit the fresh cuttings the older ones will be over misted; however, if the mist is adjusted for the older cuttings the new cuttings will dry out. A grower has limited flexibility if only one cyclic timer is used.

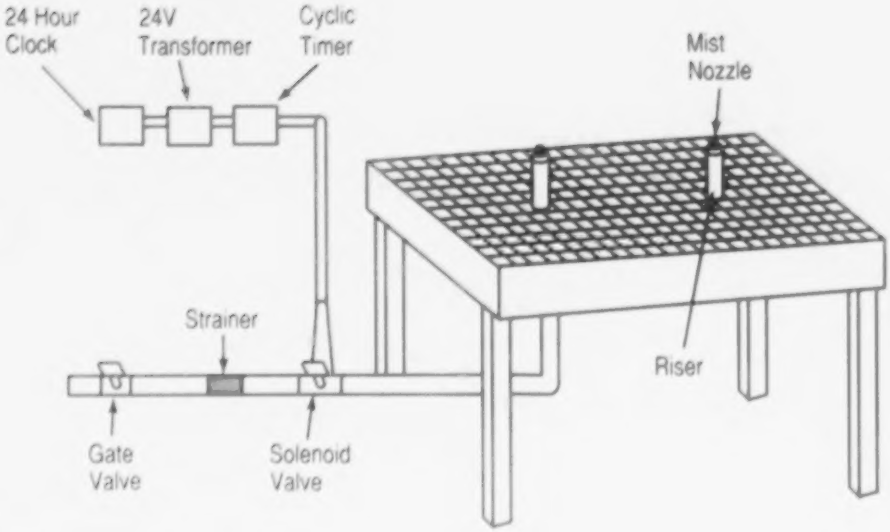
  A propagation bench can be divided into sections to give the grower flexibility. Each section of the bench will require a solenoid valve and cyclic timer. With this set up older cuttings and fresh cuttings can be on the bench at the same time and each will receive the proper amount of mist.

- **Are there any other design features that should be incorporated into the propagation system?** A properly designed mist bench should have a gate valve at the head of the bench. This is useful in case a water line or riser breaks; it allows you to shut the water off. An end cap should also be placed at the far end of the water line; it can be removed to flush the lines periodically.

  Make sure the temperature sensing devices for the heating system are located where the propagation media will be.


Day-Night Timer
5-Minute Cyclic Timer
Mist Nozzles
Electric Power
Magnetic Solenoid Valve
Gate Valve
3'-4'
Water Supply
Strainer
Themostat
Power Supply To Electric Bottom Heat Cables
Gravel Layer Over Drainage Holes
Rooting Medium (10 cm; 4")

Overhead System


24 Hour Clock
24V Transformer
Cyclic Timer
Mist Nozzle
Strainer
Riser
Gate Valve
Solenoid Valve

Under Bench Mist System

OBJECTIVE 3

Complete statements about selecting propagation containers.

The containers used for propagation will depend on the method of propagation being used and the growers schedule for producing the crop.

- Seeds are generally hand sown in 11" x 22" flats, known as seed or community flats. If only a few seeds are being sown 6" pots or undivided cell packs are acceptable.
- Automatic seeding machines use plug trays as propagation containers. The trays vary in size from 162 to 580 plugs per flat.
- Large seeds can be sown in a seed flat or directly sown in the production containers, usually some type of cell pack. Direct sowing eliminates the need for transplanting seedlings.

- Containers used for cutting propagation will vary with the plant species. Blooming pot plants are generally direct rooted in production containers; poinsettias in 6" pots and geraniums in 4" pots. If propagation bench space is limited most growers will root in jiffy pellets or one of the synthetic propagation products: Oasis strips, Rockwool strips, or Oasis wedges. These materials allow cuttings to be closely spaced so many cuttings are rooted in a small amount of space. However, transplanting is required when these products are used and the production schedule is slightly longer.

- Foliage plants are propagated in community flats, jiffy pellets or other artificial media, or small pots. They are rarely propagated in their production containers due to slow growth rates.

OBJECTIVE 4

Select from a list true statements about seed varieties and calculating planting schedules.

A grower must decide what crops will be produced and determine the production schedule for these plants. The varieties selected must perform well under outdoor conditions and be good sellers in the retail market.

- Making the plant selections.

  Every year many new cultivars are introduced in the market; and a grower must keep informed of what is available and how the plants have performed. The greenhouse trade magazines and seed company catalogs do a good job of presenting new cultivars and their cultural information.

  When selecting seed varieties choose cultivars that are successful in your location. Many plants that grow well in Michigan will not survive in Oklahoma and vice versa.

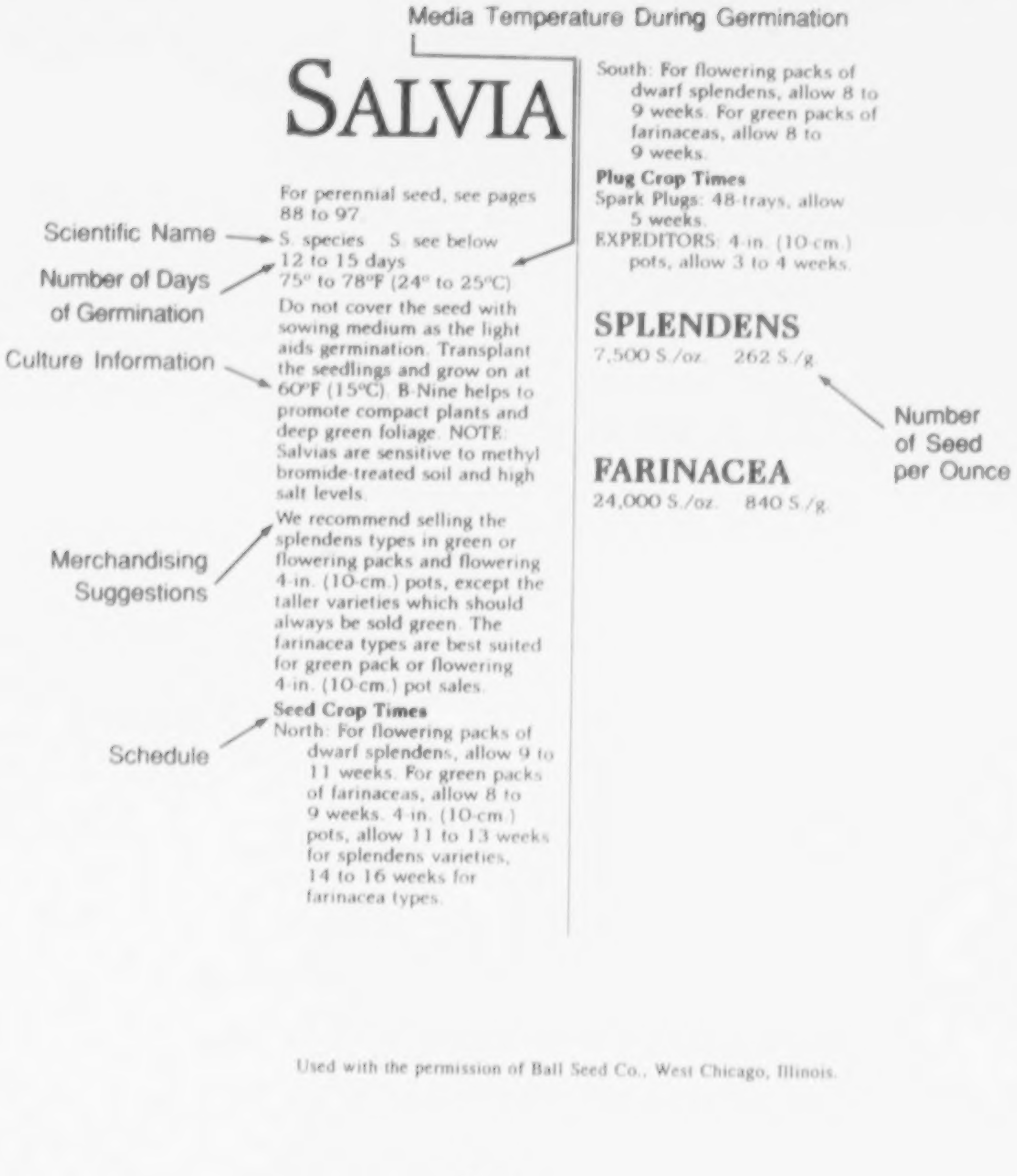
  If a new cultivar is selected for trial, grow it on a small scale and see how it performs. Have some of your repeat customers try it and see if they like it.

  All-American selection winners are usually safe new cultivars to try. The All-American selection winners have been grown and evaluated by growers, consumers and research scientists from all over the United States. Plant performance is evaluated and the best overall performers receive the award. This is a prestigious award and an AASW (All-American Selection Winner) is considered an excellent performer. However, these plants are subject to regional climatic conditions and may not perform well in some climates.

Consider the cost. Seed of new cultivars are often two or three times as expensive as older cultivars.

- Calculating a planting schedule.

  Many commercial planting schedules are available to the greenhouse grower through seed catalogs and specialized publications. These schedules are estimates of production times and should only be used as helpful guidelines. The illustration on the following page shows the typical information provided in most seed catalogs.


Media Temperature During Germination
Scientific Name
Number of Days of Germination
Culture Information
Merchandising Suggestions
Schedule
Number of Seed per Ounce

SALVIA

For perennial seed, see pages 88 to 97.

S. species S. see below

12 to 15 days

75° to 78°F (24° to 25°C)

Do not cover the seed with sowing medium as the light aids germination. Transplant the seedlings and grow on at 60°F (15°C). B-Nine helps to promote compact plants and deep green foliage. NOTE: Salvias are sensitive to methyl bromide-treated soil and high salt levels.

We recommend selling the splendens types in green or flowering packs and flowering 4-in. (10-cm.) pots, except the taller varieties which should always be sold green. The farinacea types are best suited for green pack or flowering 4-in. (10-cm.) pot sales.

Seed Crop Times

North: For flowering packs of dwarf splendens, allow 9 to 11 weeks. For green packs of farinaceas, allow 8 to 9 weeks. 4-in. (10-cm.) pots, allow 11 to 13 weeks for splendens varieties, 14 to 16 weeks for farinacea types.

South: For flowering packs of dwarf splendens, allow 8 to 9 weeks. For green packs of farinaceas, allow 8 to 9 weeks.

Plug Crop Times

Spark Plugs: 48-trays, allow 5 weeks.

EXPEDITORS: 4-in. (10-cm.) pots, allow 3 to 4 weeks.

SPLENDENS

7,500 S./oz. 262 S./g.

FARINACEA

24,000 S./oz. 840 S./g.

Used with the permission of Ball Seed Co., West Chicago, Illinois.

Environmental factors control the actual production time of a crop. If the weather is unusually cool the crop will be slower to finish; however, if the weather is extremely warm the production time will be reduced. A grower must realize the effects of the environment and try to adjust greenhouse conditions to keep the crop on schedule.

The method of propagation will effect the schedule of production. Plants that are transplanted from a seed flat into production containers usually require an additional 7-10 days to reach the market stage compared to direct sown plants. A grower who sows seed in plug trays and then finishes the crop may reduce the schedule by 7-10 days. Plugs purchased from specialized plug producers generally require only 4-5 weeks to finish. Below is an example of schedule variations for seed geraniums due to propagation techniques.

15 weeks if hand sown and transplanted
14 weeks if direct seeded
13 weeks if sown in plugs and transplanted
5-6 weeks if plugs are bought from a plug producer

To properly schedule a crop the grower must be familiar with information regarding germination and culture of the crop. This is especially true if this is the first time the crop has been grown. Special publications are reliable sources of information and usually offer helpful tips.

After germination and production information is gathered the grower can calculate the sowing date and projected transplanting date. To determine the sowing date count backwards from the planned sale date the number of weeks it takes to produce the crop. A typical schedule for red salvia is shown below.

Important information about Salvia

Germination takes 10-14 days
Production requires 10-12 weeks
Required sale date April 15

Sale date 4-15
Estimated transplant date 2-25
Sowing date 2-4

Keeping a record book of each season's production is helpful. Record sowing date, transplant date, bloom date, number of containers grown and how many were dumped. Several years worth of data should present accurate scheduling information for your greenhouse. In addition these records will let you know if you are producing adequate numbers of each species or if overproduction is occurring.

Regardless of how well you schedule a crop there will be times when production is ahead or behind schedule. Temperature, and watering rates, give the grower some control in slowing down or speeding up a crop. Reducing the night temperature and/or the amount of water applied to the crop slows the growth rate; increasing the temperature will speed up plant development. A 5-6° F change in temperature is enough to alter most plants growth rate.

OBJECTIVE 5 **Discuss germination media and seed sowing methods.**

- To guarantee high rates of germination seeds must be kept warm, moist, and have an adequate supply of oxygen. The heating system on the propagation bench can provide the correct temperature for germination, and moisture can be applied with the intermittent mist system. The germination media determines the amount of oxygen available to the seed.

- A good germination media should hold large amounts of water and yet have excellent drainage. A germination media that drains well will contain sufficient oxygen to allow germination to occur and it will also prevent damping off, a fungal disease that attacks seedlings if the media is waterlogged and poorly aerated.

- The texture of a germination media should be very fine compared to a growing media. This fine texture is necessary for sowing small seeded species like petunia and begonia, and it also holds a constant moisture level better than a coarse textured media. Milled sphagnum peat is used in germination media; this moss has a finer texture due to processing and is mainly used in germination media.

- Commercial germination media is readily available and usually has a nutrient charge incorporated in it. Redi-Earth, Metro-Mix 200, Pro-Mix Germinating Mix, Ball Germinating Mix and Jiffy Mix are commonly used germination media.

- The majority of greenhouse operators purchase some type of germination media to use with seed propagation. Growers who use automatic seeders buy specialized germination media designed for plug tray use.

- Getting the germination process off to a strong start is critical to the success of sexually propagated crops. Do not try to save money by using an inferior quality germination media, or by not purchasing the special media. The final value of a crop is worth many times more than the few extra cents it cost to use a germination mix.

- How seeds are sown is just as important as the germination media used. If a seed is improperly placed in the correct media, germination will not occur. A propagator must be aware of the germination requirements for each plant species. Light plays a critical role in the germination process; some seeds require light to germinate and others require darkness to germinate.

- A propagator should know the important information regarding the sexual propagation of the crop. Does it require light or darkness to germinate? What is the proper medium temperature during germination? How long should it take for the seeds to germinate?

- After the information is gathered the sowing process can begin. Seeds can be sown with either automatic seeders or manually. Most medium to large sized greenhouses have automatic seeders and sow the majority of their crops as plugs. Small greenhouses usually cannot afford to buy automatic seeders so they sow their seed by hand.

Automatic seeding techniques

- Seeders can be purchased from many companies and range in price from around $800 to up to $35,000.

  NOTE: A description and feature list of many seeders can be found in Bedding Plants III. This equipment is constantly being upgraded and redesigned.

- The operation of automatic seeders is based on a vacuum principle. Seeds are picked up and held in place by a vacuum; when the plug tray or cell pack is in place the vacuum is released and the seed is dropped into the tray. This vacuum is so precise that 1, 2 or 3 seeds can be dropped into each plug.

- Most machines have conveyer systems that automatically feed trays into the seeder and push them out toward the propagation area after seeding. Depending on the efficiency of the operator and machine, 5,000 - 100,000 seeds can be sown per hour.

- The actual sowing procedure depends on the machine; older models require the operator to pour the seeds on the plate and manually release the vacuum to drop the seed. Newer machines automatically fill the plates from a container of seed, drop the seed and push the tray out of the seeder; they will automatically shut themselves off if they run out of seed.

- Special seed such as detailed marigolds and pelleted begonia must be purchased to use with some seeders. Newer machines will sow most regular seed.

Manual seeding techniques

Manual sowing of seed may be done in either a seed flat or directly into production containers. Seed flats are often called community flats because lots of seeds are placed close together in one flat.

A seed flat can contain one or several varieties of seed. 11" x 22" flats are usually used for sowing seeds.

Seeds may be placed in a community flat by:

- Broadcasting—Random scattering of the seed over the media surface in the flat.
  - Limited to one cultivar per flat to insure proper labeling.
  - Disease spreads quickly over the entire flat once it starts.
  - Difficult to transplant since the plants are scattered.
  - Can be sown quickly.
- Sowing in rows—Seeds are placed in rows within the flat.
  - Allows for several cultivars to be sown in the same flat. Rows should be one and a half to two inches apart.
  - Disease is usually confined to the row it starts in.
  - Easier to transplant since all the plants are together in a row.
  - Requires extra time to sow.
- Community flats require small amounts of propagation space for germination; one flat may contain 700 - 1000 seeds.
- Germination media is necessary since most seeds are small sized.
- Sowing of seed is quick, but a large amount of time is required to transplant the seedlings.

Procedures for sowing a community flat

1. Moisten germination media and fill containers. Make sure the containers are completely filled with media; this provides optimum drainage.

2. If sowing in rows use a stake or ruler to mark off the rows in the media. Only make the trenches deep enough to see if the crop requires light; make a row 1/4" deep for crops that need darkness to germinate.

3. Sprinkle the seeds over the media surface if broadcasting. If sowing in rows, sprinkle the seeds in the trenches. Try to evenly space the seeds out as they are being sown. If seeds are sown too closely together the seedlings will be weak and leggy, and the root systems will be tangled. **SOWING SEED TAKES PRACTICE.**

   NOTE: Bedding Plants III manual recommends that only 1000 -1200 small sized seeds be sown in a flat or 750 - 1000 large sized seed per flat.

4. Cover the seeds that require darkness with 1/8" - 1/4 " of media. If the flat was broadcast, sprinkle additional media over the entire flat. A small wooden frame with window screen attached can be used to sift media onto the surface. If the flat was sown in rows, pinch the rows shut with your fingers or sprinkle additional media on top of the row.

5. Label and date the flat with a waterproof marker; label and date each row in a seed flat.

6. Water in with a mist nozzle.

7. Place in the propagation area.

Direct sowing techniques

- Involves placing one or more seeds directly into the production container for germination.

- Limited to large sized seeds (marigold, zinnia, dahlia, etc.) that are easy for employees to work with.

- Production containers are usually cell packs, peat pots or small plastic pots.

- Special germination media is not needed; they are sown in the growing media.

- Requires additional time to sow but transplanting is completely eliminated.

- Additional propagation space is required for the large number of containers.

Procedures for direct sowing seed

1. Moisten media and fill containers.
2. Dibble holes 1/4" - 1/2" deep in each container.
3. Drop one or more seeds in each hole. Some growers prefer to place two seeds in each hole to guarantee a plant in each container. If both seeds germinate one seedling will be pinched out. The number of seeds placed in each hole will depend on the germination rate for the species.
4. Pinch the holes shut. Extra media may be added to the container if necessary.
5. Label and date the flat with a waterproof marker.
6. Water in and place on the prop bench.

   NOTE: Some species do not require the use of mist to germinate

OBJECTIVE 6

Arrange in order the stages of seed germination.

For a seed to germinate and become a new plant many biological and chemical processes must occur within the seed. Often a grower is unfamiliar with the stages of germination because they are not seen.

Below are the steps that occur during germination.

1. Viable seed sown. Viable seed is alive and capable of germination. If a seed has been stored improperly, or for a long period of time, it loses viability.
2. Seed absorbs water from the medium. The internal water content of a seed is very low, about 10%, and when placed in moist medium the seed pulls water inside.
3. Swelling of the seed occurs and the seed coat breaks open.
4. Enzymes are activated and synthesized.
5. Cells begin elongating and radicle emerges from the seed coat.
6. Stored food in the endosperm is digested. This energy is translocated to the radicle which now extends into the growing medium, and to the newly emerging shoot.

7. The shoot breaks through the medium surface and cotyledons expand.
8. Cell division begins.
9. Seedling plant emerges with true leaves.
10. Germination is complete and the new plant is able to photosynthesize.

OBJECTIVE 7 **Describe the proper method for transplanting seedlings.**

The transplanting process involves moving the seedlings from the seed flat to the production container. Care must be used to preserve the root system of the seedling and to avoid injuring the plant. If transplanting is done improperly a large percentage of the seedlings will die.

The steps in transplanting depend on the method of seedling production. Seedlings produced in a seed flat are more difficult to transplant than plants produced as plugs.

- Transplanting seedlings from a seed flat.
    1. Observe seedlings and transplant as soon as ready. Seedlings should have two true leaves and be large enough to handle; usually seven days after germination. If seedlings get too big before transplanting the root systems become entangled and will be damaged during transplanting.
    2. Seedling flat should be well watered before transplanting begins.
    3. Fill production containers with moist growing media.
    4. Dibble holes for seedlings; use a pencil, label, dibbling board or your finger.
    5. Loosen germination media under the seedlings; a pencil or your finger work well.
    6. Lift a clump of seedlings, with media attached to the roots, from the seed flat. Sort the seedlings according to size. Seedlings must be of equal size and vigor to produce a uniform finished flat.
    7. Remove one seedling from the clump and place it in a dibbled hole. **Only touch the seedling by the leaves; do not touch the stem.** If a leaf is injured or killed other leaves will replace it; however, if the stem is injured the seedling will die.

8. Place the rest of the seedlings from the clump into the dibbled holes.

9. Tighten the media around the seedlings that have been placed in the holes. Make sure the growing point is not buried. Only compress the media enough to hold the seedling upright.

10. Repeat the process until the production container is finished.

11. Water the seedlings immediately after transplanting. Some growers choose to apply a fungicide drench when the crop has been transplanted.

- Transplanting plugs

  1. Observe plugs and transplant when ready.
  2. Fill production containers with moist media.
  3. Make sure plug media is well watered before transplanting.
  4. Loosen plugs and remove them from the tray.
  5. Dibble holes in production containers. Some people choose not to dibble holes; they simply push the plug into the media. This may be harmful to delicate roots.
  6. Drop plugs into the holes and tighten media around the plug.
  7. Water plugs immediately after transplanting and apply a fungicide drench after the crop has been watered if desired.

- If the weather is extremely bright or hot at transplanting time, hand mist, or apply shade to the transplants until they are established. This will protect them until their roots are adequately absorbing water.

OBJECTIVE 8

Select from a list true statements about preparing seed for storage.

It is generally not recommended that a grower try to store large volumes of seed. However, many people will store small amounts of seed for next year's use.

- Correctly stored seed has an internal moisture content of 10-15%; this low moisture content guarantees high viability rates when the seed is removed from storage. Growers cannot reduce the internal moisture content and the seed loses viability during storage.

- Seeds can be purchased in very small quantities and growers should purchase only the amount of seed required. This eliminates the need for storage and provides higher germination rates.

- Seeds naturally lose viability as they age. Bedding plants have a short viability period and it is further reduced by storage.

- If seed must be stored follow these steps:

  1. Make sure the seed is dry.
  2. Place seed in an air tight container.
  3. Store at 40°-50° F with 40-50% humidity.

     NOTE: A number of growers store seed in airtight containers in a freezer.

  4. Test germination rates before using seed.

OBJECTIVE 9

Complete statements about producing and maintaining stock plants for asexual propagation.

Asexual propagation uses vegetative tissue from a parent plant (stock plant) to create new plants. Greenhouses grow and maintain stock plants for the purpose of supplying large numbers of cuttings for propagation.

- Stock plants are usually started at least four months before the desired propagation date. This is done so the plants can be pinched and have time to produce cutting material.

- Pinching should be done at frequent intervals to promote initiation of new shoots. A typical pinching schedule for poinsettia stock plants is shown on the following page.

Plant rooted cuttings	March 15	April 15	May 15	June 15
1st pinch (at 2 weeks) 6 breaks	March 30	April 30	May 30	June 30
2nd pinch (at 6 weeks) 15 breaks	April 30	May 30	June 30	
3rd pinch (at 10 weeks) 24 breaks	May 25	June 25		
4th pinch (at 14 weeks) 30 breaks	June 25			
Harvest 1st cuttings, August 1 number	30	24	15	6
Harvest 2nd cuttings, September 5 number	50	30	24	15
Total cuttings/stock plant	80	54	39	21

Used with permission of Paul Ecke's Ranch

- Make sure the stock plants are clearly labeled with the correct cultivars.

- Monitor stock plants closely for insect or disease problems. These plants should be healthy and clean. If disease infects a stock plant discard it; disease will rapidly spread when cuttings are placed on a propagation bench.

- Provide optimum nutrition to stock plants. The goal in stock plant production is to produce as many healthy cuttings as possible. Plants that are nutrient deficient produce very few cuttings, and they are of poor quality.

- Stock plants must be in the proper physical state for asexual propagation. Cutting should not be allowed to set flower buds; flowering inhibits rooting. If proper pinching is done flowering will not be a problem.

- Stock plants are usually maintained for one season and then discarded. Starting with new stock plants each year reduces the risk of disease. Also, as stock plants get older they become too large to manage and the number of new cuttings produced slows.

OBJECTIVE 10 **Discuss preparing for harvesting cuttings.**

Many procedures and treatments must be completed before cuttings are taken from stock plants. These steps will increase the success rate of asexual propagation. These steps should be completed the day before cuttings are harvested.

1. Decide on the number of cuttings to be harvested; make sure the cuttings are available.
2. Sterilize the propagation bench and nozzles. Test the nozzles to see that they are working properly.
3. Test heating system and adjust as needed.
4. Place propagation containers on the bench and turn on the intermittent mist. This wets the media and eliminates dry spots.
5. Hand water synthetic propagation strips one time to initially wet them.
6. Dibble holes in containers with growing media. This allows for quick sticking of the harvested cuttings.
7. Water stock plants twice; once in the morning and once in the afternoon.
8. Spray stock plants with a fungicide solution; it reduces the risk of disease during propagation.
9. Gather tools and supplies needed for harvesting cuttings. Sharpen knives if necessary.
10. Discuss with employees that cuttings will be taken early the next morning.

OBJECTIVE 11

Describe the proper procedure for harvesting cuttings.

The following procedures should be used when harvesting cuttings:

1. Explain to the propagators the type, and size, of cuttings to be taken. Stem tip cuttings should be two to four inches in length and the growing point must be present.
2. Use a sterile container to hold harvested cuttings.
3. Prepare a solution for sterilizing hands and knives. A 10% clorox solution or any other greenhouse disinfectant will work.
4. Dip hands, forearms and knives in the solution. Wet hands and knives will not hurt the cuttings.
5. Harvest a cutting by making a clean cut with a knife. The cutting does not have to be taken at a node.
6. Redip hands and knives after every 25-30 cuttings.
7. Collect cuttings from one cultivar at a time; this eliminates mistakes in labeling.
8. When 75-100 cuttings have been taken, stop and stick these cuttings. Quick sticking reduces water loss and wilting of the cuttings.

   NOTE: If the sticking operation is interrupted for several hours due to emergencies, cuttings can be stored in the cooler.

9. Resume taking cuttings.
10. If a cutting is dropped - **throw it away!** The greenhouse floor is contaminated and that one cutting is not worth infecting the entire propagation bench.

OBJECTIVE 12

Discuss applying root promoting chemicals.

- Root promoting chemicals, commonly called rooting hormones, are applied to cuttings to speed up the initiation and development of adventitious roots.

- IBA (indolebutyric acid) and NAA (naphthaleneacetic acid) are the most frequently used hormones.

- IBA is generally considered the best material because it is safe over a wide range of concentrations and is very effective on almost all plants.

- These materials can be purchased as a liquid, powder, or concentrated substance for the grower who wishes to make their own rooting hormone.

- Rooting hormones are purchased in different concentrations depending on the difficulty in rooting the species.

  Hormex No.1 - greenhouse and garden plants

  Hormex No.3 - nursery crops

  Hormex No.8 - evergreens

  The larger the number the higher the amounts of IBA present.

- Some rooting hormones are available that contain a fungicide to prevent disease.

Applying rooting hormones using these methods:

POWDERS

1. Pour a small amount of powder (0.5 - 1 inch deep) in a saucer or other shallow container. **NEVER** stick cuttings into the original container of rooting hormone; it will contaminate the entire supply of hormone.

2. Collect a handful of cuttings; cut ends together.

3. Dip the cut ends into the powder. If the wound is dry and the powder will not stick, wet the cut ends.

4. Remove excess powder by tapping the cuttings with your finger or by tapping the cutting gently on the edge of the saucer. Excess hormone can inhibit rooting.

5. Immediately stick the cuttings.

6. When finished sticking cuttings discard the hormone in the saucer. **Do not pour it back into the stock container of hormone**. Bacteria or fungi could be introduced into the stock container.

NOTE: Some growers feel that the saucer method spreads disease. They put the powder into a squeeze bottle and dust the hormone on the cuttings.

LIQUIDS

1. Place a small amount (0.5 - 1 inch) of the hormone solution in a beaker or other suitable container.
2. Gather a handful of cuttings; cut edges together.
3. Immerse the cut ends into the solution for about 30 seconds; read directions for the exact length of the dip period.
4. Remove cuttings and shake excess hormone.
5. Stick cuttings.
6. Throw away the remaining solution when finished sticking cuttings.

- Rooting hormones are relatively inexpensive and are a good investment. They hasten rooting and improve the quality of the root system produced.
- Store rooting hormone in a refrigerator to extend its life.

OBJECTIVE 13 **Discuss sticking cuttings.**

The way a cutting is stuck into the propagation media determines the success or failure of the rooting procedure.

- Media should be moist before the cutting is inserted.
- Intermittent mist should be operating while cuttings are being stuck. This prevents the cuttings from wilting.
- Remove any leaves that will be below the media surface when stuck. Foliage buried in the media will rot during propagation and can infect other cuttings with disease.
- Treat cuttings with rooting hormone.

- Drop the cuttings into pre-dibbled holes; do not compress the media around the cuttings.

- If using Oasis or rockwool strips only push the cuttings deep enough into the media to hold them upright.

- Cuttings that have been dropped should be discarded.

- After all cuttings have been stuck observe the plants and readjust any foliage that is covering the apical meristems. Cuttings that do not receive mist on the growing points will die.

- Hand water all cuttings. This will firm the media around the cuttings.

- Adjust the mist settings based on weather conditions and the type of cutting. There should be a thin film of water on the foliage at all times.

OBJECTIVE 14

Discuss transplanting rooted cuttings.

Cuttings will usually have rooted 14-21 days after sticking. These newly rooted plants must be prepared for the move into a production greenhouse.

1. Slowly begin reducing the mist 7-10 days before moving the plants from the propagation house. This acclimates the plants to the production environment and forces the transpiration system to begin working.

2. Thoroughly water the rooted cuttings immediately before they are taken from the propagation bench to the transplanting area.

   — Plants that were direct rooted can be placed on the production bench after acclimatization. Make sure these plants are carefully monitored for water the first week out of the propagation house.

   — Cuttings that were rooted in small pots or synthetic strips must be transplanted into production containers.

3. Fill the production container with growing media and make a hole in the center for the cutting.

4. Carefully set the newly rooted plant and propagation media in the hole and compress the growing media around the root system; this will hold the cutting upright.

   - Oasis or rockwool cubes should be buried when transplanted. If part of the cube sticks up above the media it will wick water away from the roots and the plant will perform poorly.

5. Double water the plants after transplanting. This eliminates air pockets and puts the media in direct contact with the root system.

6. Place the newly transplanted cuttings in a production greenhouse.

7. After all the cuttings are potted and placed on the production bench apply a broad spectrum fungicide drench.

8. Fertilization programs should be started at the first watering after the fungicide drench.

   - Plants that were propagated in synthetic media should be watered every day for the first 2-3 days; this helps keep the synthetic cube wet until the roots reach out into the growing media.

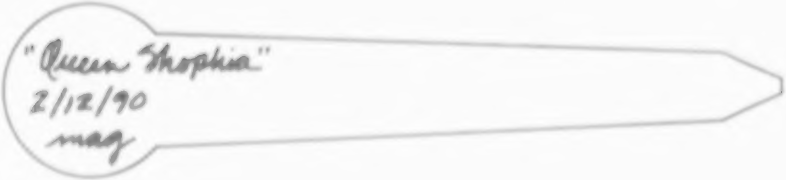
OBJECTIVE 15

Discuss labeling plants during propagation.

Every consumer looks for a cultivar name on the plants they purchase. They expect the flower color to be what the label says it will be; they are dissatisfied when it is not. Improper labeling during propagation results in mislabeled cultivars and unhappy customers.

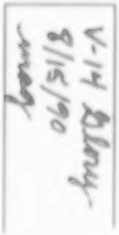
- When seeds are sown:

  - Identify every flat or propagation container with the cultivar name and sowing date using a permanent marker. Some propagators put their initials on the containers they have sown.



- If seeds were sown in a community flat each row of seed must be labeled.
- Some people choose to mark the information on the outside of the propagation container instead of a label. This does away with the problem of labels getting lost or switched.
- When seedlings are transplanted into production containers they must be labeled; every cell pack or pot should be identified. Most seed companies sell preprinted labels that have the cultivar name and a picture of the plant. These labels allow transplanters to quickly tag each container and the consumer knows what the plant should look like.
- Many growers like to keep empty seed packs as a source of information in case any questions should arise.

- When cuttings are stuck:
  - Each propagation container must be identified with the cultivar name and the sticking date; propagators initials may be required.



  - One label per Oasis or rockwool strip is sufficient if the same cultivar is in the strip.
  - When transplanting time comes every production container must be labeled. Since most cutting propagated plants are grown in 4" pots or larger, the information can be written on the outside of the pot. Stacks of pots can be labeled before transplanting time and this helps speed up the transplanting process. Preprinted color labels are also commonly used.

OBJECTIVE 16 **Discuss the propagation of microcuttings.**

Commercial laboratories across the United States are now able to produce huge numbers of a plant using sterile tissue culture techniques. Some companies sell these tiny plants before they have formed roots. These plants are called "microcuttings" because they look like microscopic stem tip cuttings; they are usually one-half to one inch tall.

- A grower orders microcuttings from a company and they are shipped in plastic bags. Microcuttings are relatively inexpensive and freight is low because many cuttings fit into a single bag. It is the job of the propagator to produce roots on these plants.

- Rooting hormones are used on microcuttings at sticking time. The cuttings are placed on a propagation bench and held there until roots have formed.

- Strict sanitation must be used during the propagation of microcuttings. These plants are coming from a sterile environment and they must be protected until they are acclimated to the greenhouse environment.

- After rooting, these plants are hardened and transplanted like regular cuttings.

OBJECTIVE 17 **Discuss propagation by division.**

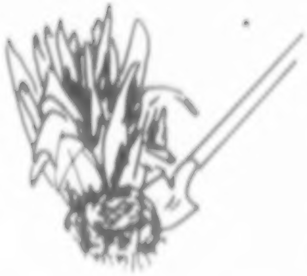
- Division is a propagation method that involves the cutting, or dividing, of the parent plant into several new plants.

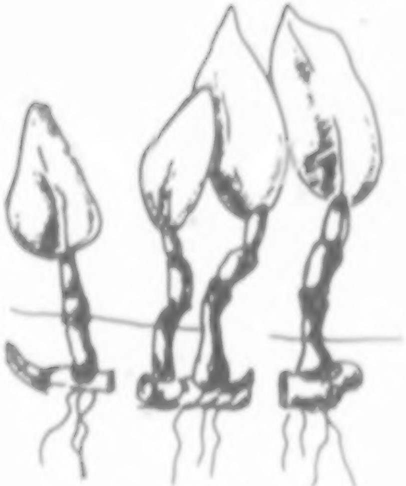
- Division is done when a plant becomes too large for the pot; ferns are good examples. A large parent plant is cut in half or thirds and each portion is potted up and becomes a new plant.

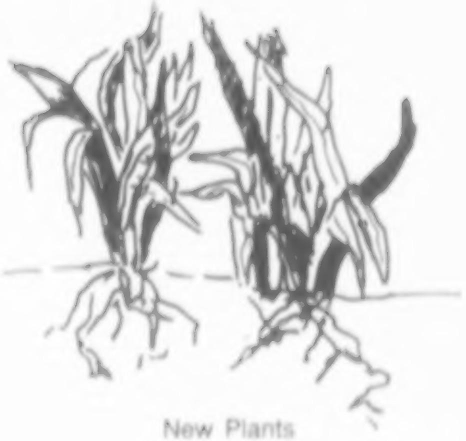
- Some plants produce offspring that are attached to the parent. These new plants are removed or divided away from the parent plant and repotted into a container; bromeliads are propagated this way.

- Some plants do not reproduce true to form if propagated by cuttings. A variegated sansevieria is an example of a plant that must be propagated by division. If leaf cuttings are taken the new plants produced will be solid green; the variegation is lost in the cutting procedure.

- Division results in large plants being produced quickly, but only a few plants can be produced.


Plant to be Divided


Root or Stem Section


New Plants

OBJECTIVE 18

Select from a list true statements about propagation by layering.

- Layering causes adventitious roots to form on a stem while it is still attached to the parent plant. After rooting, the new plant is removed from the parent and potted in a separate container.

- Air layering is usually done on large leggy plants such as ficus or dieffenbachia. These plants are too large to successfully propagate by stem tip cuttings.

  1. Wound the stem 12-18" from the tip. Girdling or making a slanting cut 1/3 the way through the stem is a sufficient wound. If the cutting method is used, a match stick or tooth- pick should be inserted to hold the wound open.
  2. Apply rooting hormone to the wound and pack a handful of moist sphagnum moss around the treated wound.
  3. Seal with plastic and secure the ends.

4. After several weeks roots will appear in the moss; the plant is then ready to be removed from the parent plant and potted.

- Simple layering places a bent stem in propagation media and forces roots to form. After it has rooted the plant is removed.
  - Older dieffenbachias and aglaonemas develop weak, bent stems. These bent stems can be wounded by making a cut 1/3 through the stem or by slicing a thin layer off the bottom side of the bent stem.
  - Treat the wound with rooting hormone and place a pot of growing media under the wounded stem. Add more media to completely cover the bent portion of the stem.
  - After several weeks the bent stem will have rooted and can be removed from the parent plant.
- Layering techniques produce only a few new plants but they are usually large sized.

ASSIGNMENT SHEET 1

PROPAGATING PLANTS

IV

NAME ______________________________ SCORE ________

OBJECTIVE 19

Design a propagation bench.

INTRODUCTION

Objective 2 discusses all the necessary parts of a well designed propagation bench. Use the information in Objective 2 to complete this Assignment Sheet.

DIRECTIONS

On a separate sheet of paper, sketch a propagation bench that you plan to construct. Make sure to include the bench dimensions, nozzle spacing, riser height if needed, bench height, the location and type of heat source, solenoid, time clocks, strainer and gate valve. Your drawing should be detailed enough so that a person unfamiliar with greenhouses could build the bench.

List the name of each item that has to be purchased and how much it costs. The A.H. Hummert catalog has all the necessary information.

ASSIGNMENT SHEET 2

PROPAGATING PLANTS

IV

NAME ______________________________ SCORE ________

OBJECTIVE 20 **Determine the correct conditions for seed germination.**

INTRODUCTION Objective 4 discusses the importance of knowing the germination requirements for a plant species. The activity on this assignment sheet emphasizes this area.

DIRECTIONS Read the information given for a plant species and then answer the questions regarding germination.

ALYSSUM

For perennial seed, see pages 88 to 97.

Lobularia maritima
90,000 S./oz. 3,150 S./g.
8 to 10 days
80° to 82°F (26° to 28°C)

Sow direct to the final containers, using a number of seeds to provide 10 to 15 seedlings in each cell or 4-in. (10-cm.) pot. Do not cover the seed, exposing it to light for germination. Water with warm water; watch closely for damping off.

Seed Crop Times
North: Packs, allow 8 to 9 weeks. 4-in. (10-cm.) pots, 10 to 11 weeks.
South: Packs, allow 7 weeks. 4-in. (10-cm.) pots, 9 weeks.

Plug Crop Times
Spark Plugs: 48-trays, allow 5 to 6 weeks.

White-flowered varieties are the most vigorous of the colors, and the most heat-tolerant. In the northern U.S., alyssums may suffer heat stall during the hottest part of the summer, and some may die out. However, the white varieties will reflower once the night temperatures cool. In the deep South, summer plantings do best in partial shade.

Oriental Night
1132 An early variety, Oriental Night produces dark violet blooms on compact plants that spread up to 8 in. (20 cm.) across. Price code C.

Rosie O'Day
1131 Unusual, lavender rose flowers with a moderately early blooming time highlight plants that spread as much as 10 in. (25.5 cm.) across. Price code A.

ALYSSUM SEED PRICES

DON'T MISS OUR SPECIAL DISCOUNTS SHOWN ON PAGE 10.

QUANTITY	A	B	C	D	E
1/16 oz.	—	—	—	$ 5.10	$ 8.05
1/8 oz.	—	—	$ 4.95	9.40	14.90
1/4 oz.	$ 5.50	$ 6.50	9.10	17.40	27.60
1/2 oz.	10.35	12.20	17.10	32.80	52.00
1 oz.	19.50	22.95	32.25	61.90	98.05
4 oz.	75.10	88.35	124.20	238.35	377.50

All prices are coded. Use the letter following the description and find the corresponding price above. Varieties cannot be grouped for total seed weight or price.

Used with the permission of Ball Seed Co., West Chicago, Illinois.

1. At what medium temperature should a flat of alyssum seed by germinated?
2. Does alyssum seed require light or darkness to germinate?
3. How long should alyssum germination take?
4. About how long will it take to produce salable alyssum in cell packs in a southern environment?

MARIGOLD

Tagetes erecta (African)
Tagetes patula (French)
Tagetes erecta x patula (Triploid)
9,000 S./oz. 315 S./g.
7 days
75° to 80°F (24° to 26°C)

Sow the seed in light, moist growing medium and cover it lightly. Grow on at 65° to 68°F (18° to 20°C).

Seed Crop Times

North: Dwarf varieties in packs, allow 8 to 10 weeks for French and triploid types; African varieties flower in 11 to 12 weeks.
4-in. (10-cm.) pots, allow 11 to 12 weeks for French and triploid types; 12 to 13 weeks for African varieties.

South: Dwarf varieties in packs, allow 7 to 9 weeks for French and triploid types; 10 to 11 weeks for African varieties. 4-in. (10-cm.) pots, allow 10 to 11 weeks for French and triploid types; 11 to 12 weeks for African varieties.

Plug Crop Times

Spark Plugs: 48-trays, allow 4 to 6 weeks for French types; 5 to 6 weeks for African varieties.

EXPEDITORS: 4-in. (10-cm.) pots, allow 5 to 7 weeks for French types; 6 to 8 weeks for African varieties.

African marigolds are daylength-sensitive and respond best to nine hours of light. However, shading is only necessary if the seed is sown after February 15. To germinate, sow the seed and cover the flat with black plastic, or place an inverted flat without holes over the top. Keep the sown flat covered from 5 p.m. to 8 a.m. Follow this procedure for 14 days, then continue with your regular program. This short-day treatment helps produce a smaller overall plant habit, plus earlier and more uniform blooming.

We recommend selling African marigolds green in the pack, especially if they're grown in small cell-packs, since the plants are susceptible to Botrytis and Rhizoctonia.

Used with the permission of Ball Seed Co., West Chicago, Illinois.

1. At what medium temperature do marigolds germinate best?
2. Should marigold seed be covered when sown?
3. How long should germination of marigolds take?
4. How many marigold seeds are in 1/4 ounce?

ASSIGNMENT ANSWERS

PROPAGATING PLANTS

IV

ASSIGNMENT SHEET 1

Students answers will vary.

Insure that the student's drawing contains all of the components needed for a functional propagating bench.

ASSIGNMENT SHEET 2

Alyssum

1. 70° F (21° C)
2. Light
3. 8 days
4. 7 weeks

Marigold

1. 75-80° F (24-27° C)
2. Yes
3. 7 days
4. 2,250

JOB SHEET 1

PROPAGATING PLANTS

OBJECTIVE 21a

Produce a crop from seed.

INTRODUCTION

The majority of bedding plants are produced from seed. Every greenhouse employee should know how to sow seed, transplant seedlings and finish a seedling crop.

EQUIPMENT AND SUPPLIES

- Seed
- Germination medium
- Flats and cell packs
- Propagation space
- Labels and permanent markers

PROCEDURE

1. Obtain seed from your instructor; look up the germination information for your crop.
2. Calculate the germination date and sale date; use today as the sow date.
3. Sow one-half of the seed in a seed flat and place it on the propagation bench. Make sure to label it correctly.
4. Direct sow the remaining half of the seed into cell packs. Label the packs and place on the propagation bench.
5. Remove from the mist when germinated.
6. Transplant the seedlings from the community flat into cell packs when ready.
7. Watch the growth rates of the transplanted crop compared to the direct seeded plants.
8. Check and see how closely the plants growth corresponded to your estimated schedule.
9. Put away equipment and supplies.

JOB SHEET 2

PROPAGATING PLANTS

IV

OBJECTIVE 21b

Produce plants from stem tip cuttings.

INTRODUCTION

Stem tip cuttings are used to produce numerous greenhouse pot plants. The following procedure is adaptable to any crop that is propagated by stem tip cuttings.

EQUIPMENT AND SUPPLIES

- Stock plants
- Knife, container to hold cuttings and sterilizing solution
- Rooting hormone, labels and permanent marker
- Propagating media and bench space

PROCEDURE

1. Discuss with your instructor what stock plant and propagation media will be used.
2. Fill containers with media and put them on the propagation bench. If using Oasis or rockwool, hand water the strips one time.
3. Turn on mist and adjust cycle.
4. Sterilize knives and hands.
5. Harvest three to four inch terminal cuttings; remove leaves from the lower one inch.
6. Apply rooting hormone and stick the cuttings.
7. Thoroughly water the cuttings after sticking is completed.
8. Adjust mist as needed.
9. Transplant cuttings when ready, if necessary.
10. Finish the crop in the production greenhouse.
11. Put away equipment and supplies.

JOB SHEET 3

PROPAGATING PLANTS

IV

OBJECTIVE 21c

Produce plants from leaf bud cuttings.

INTRODUCTION

Leaf bud cuttings are another way to propagate greenhouse plants. With this technique only a small piece of stem and leaf tissue is required. This method allows the propagator to get lots of cuttings from one stock plant.

EQUIPMENT AND SUPPLIES

- Stock plant
- Knife, container for cuttings and sterilizing solution.
- Rooting hormone and permanent marker
- 8" hanging basket and growing media
- Propagation bench space

PROCEDURE

1. Fill the baskets with media and place on the propagation bench.
2. Start the mist and make any needed adjustments.
3. Sterilize hands and knives.
4. Harvest leaf bud cuttings. There should be one inch of stem below the bud and one-half inch above the bud. Eight cuttings will be stuck in each basket.
5. Apply rooting hormone; make sure it is put on the correct end of the stem.
6. Insert six cuttings around the outer edge of the basket and two cuttings in the center of the basket. Push the cuttings into the media so the bud is one-half inch below the media surface.
7. Label the basket and water the cuttings.
8. Adjust the mist as needed.
9. Remove from the propagation house when rooted and finish in a production area.
10. Put away equipment and supplies.

JOB SHEET 4

PROPAGATING PLANTS

IV

OBJECTIVE 21d

Produce plants using division techniques.

INTRODUCTION

Some plants do not reproduce true to form if propagated by cutting techniques. Other plants grow so rapidly that they quickly become pot bound. Both of these situations can be corrected by dividing the parent plant.

EQUIPMENT AND SUPPLIES

- Parent plant
- Knives, containers
- Growing media, labels, permanent marker
- Fungicide solution

PROCEDURE

1. Discuss with your instructor what parent plant to divide and what containers will be used.
2. Knock the parent plant from its container. You should be able to see where new plants have formed and started to grow.
3. Take a knife and cut these new plants and a portion of the media away from the parent plant. Each new plant should have a well developed root system.
4. Pot these newly separated plants and label with the date and cultivar.
5. Water thoroughly and drench with a fungicide solution.
6. Place in a production greenhouse.
7. Put away equipment and supplies.

PRACTICAL TEST 1

PROPAGATING PLANTS

IV

JOB SHEET 1

Produce a crop from seed.

Student's name ____________________ Date __________

Evaluator's name ____________________ Attempt no. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Obtained seed and looked up germination information.	_____	_____
2. Calculated the germination date and sale date.	_____	_____
3. Sowed one-half of the seed in a seed flat and placed it on the propagation bench. Made sure it was labeled correctly.	_____	_____
4. Direct sowed the remaining half of the seed into cell packs. Labeled the packs and placed on the propagation bench.	_____	_____
5. Removed from the mist when germinated.		
6. Transplanted the seedlings from the community flat into cell packs when ready.	_____	_____
7. Watched the growth rates of the transplanted crop compared to the direct seeded plants.	_____	_____
8. Checked to see how closely the plants growth corresponded to the estimated schedule.	_____	_____
9. Put away equipment and supplies.	_____	_____

EVALUATOR'S COMMENTS

____

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key). A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Flat labeled correctly	4	3	2	1
Container filled with media correctly	4	3	2	1
Correct planting depth	4	3	2	1
Seedling uniformity	4	3	2	1

EVALUATOR'S COMMENTS

____

____

____

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" on the following page.

201

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training

3 - Moderately skilled—Has performed job during training program; limited additional training may be required

2 - Limited skill—Has performed job during training program; additional training is required to develop skill

1 - Unskilled—Is familiar with process; but is unable to perform job

PRACTICAL TEST 2

PROPAGATING PLANTS

IV

JOB SHEET 2

Produce plants from stem tip cuttings.

Student's name ______________________________ Date ____________

Evaluator's name ______________________________ Attempt no. ______

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Discussed what stock plant and propagation media would be used.	_____	_____
2. Filled containers with media and put them on the propagation bench.	_____	_____
3. Turned on mist and adjusted cycle.	_____	_____
4. Sterilized knives and hands.	_____	_____
5. Harvested three to four inch terminal cuttings; removed leaves from the lower one inch.	_____	_____
6. Applied rooting hormone and stuck the cuttings.	_____	_____
7. Thoroughly watered the cuttings after sticking was completed.	_____	_____
8. Adjusted mist as needed.	_____	_____
9. Transplanted cuttings when ready, if necessary.	_____	_____
10. Finished the crop in the production greenhouse.	_____	_____
11. Put away equipment and supplies.	_____	_____

EVALUATOR'S COMMENTS

____

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key). A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Properly prepared container	4	3	2	1
Container properly labeled	4	3	2	1
Adjusted mist properly	4	3	2	1
Cuttings placed and watered properly	4	3	2	1
Cuttings successfully rooted	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" on the following page.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training
3 - Moderately skilled—Has performed job during training program; limited additional training may be required
2 - Limited skill—Has performed job during training program; additional training is required to develop skill
1 - Unskilled—Is familiar with process; but is unable to perform job

JOB SHEET 3

Produce plants from leaf bud cuttings.

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Filled the baskets with media and placed on the propagation bench.	_____	_____
2. Started the mist and made any needed adjustments.	_____	_____
3. Sterilized hands and knives.	_____	_____
4. Harvested leaf bud cuttings.	_____	_____
5. Applied rooting hormone.	_____	_____
6. Inserted six cuttings along the outer edge of the basket and two cuttings in the center of the basket.	_____	_____
7. Labeled the baskets and watered the cuttings.	_____	_____
8. Adjusted the mist as needed.	_____	_____
9. Removed from the propagation house when rooted and finished in a production area.	_____	_____
10. Put away equipment and supplies.	_____	_____

EVALUATOR'S COMMENTS

____

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key). A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Properly prepared container	4	3	2	1
Container properly labeled	4	3	2	1
Adjusted mist properly	4	3	2	1
Cuttings placed and watered properly	4	3	2	1
Cuttings successfully rooted	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" on the following page.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training
3 - Moderately skilled—Has performed job during training program; limited additional training may be required
2 - Limited skill—Has performed job during training program; additional training is required to develop skill
1 - Unskilled—Is familiar with process; but is unable to perform job

PRACTICAL TEST 4

PROPAGATING PLANTS

IV

JOB SHEET 4

Produce plants using division techniques.

Student's name ____________________________ Date ___________

Evaluator's name ___________________________ Attempt no._____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Discussed what parent plant to divide and what containers to use.	______	______
2. Knocked the parent plant from its container.	______	______
3. Took a knife and cut new plants and a portion of the media away from the parent plant.	______	______
4. Potted the newly separated plants and labeled with the date and cultivar.	______	______
5. Watered thoroughly and drenched with a fungicide solution.	______	______
6. Placed in a production greenhouse.	______	______
7. Put away equipment and supplies.	______	______

EVALUATOR'S COMMENTS

____

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key). A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Properly divided parent plant	4	3	2	1
New plant transplanted correctly	4	3	2	1
Plant labeled correctly	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training

3 - Moderately skilled—Has performed job during training program; limited additional training may be required

2 - Limited skill—Has performed job during training program; additional training is required to develop skill

1 - Unskilled—Is familiar with process; but is unable to perform job

WRITTEN TEST

PROPAGATING PLANTS

IV

NAME ______________________ SCORE ______

OBJECTIVE 1

Match terms associated with propagation to their correct definitions. Write the correct letters in the blanks.

____ 1. A method of propagation that uses a section of the plant stem with a leaf amd axillary bud to produce a new plant

____ 2. Increasing the numbers of a plant through reproductive techniques used by greenhouse growers

____ 3. Leaves that are initiated by a seedling plant; they are the leaves that appear after the cotyledons have emerged and are typical of the species

____ 4. Mass of undifferentiated cells that form near the wound on a cutting

____ 5. A method of propagation that uses a leaf blade or leaf blade and petiole to produce a new plant

____ 6. An embryo that has a stored food supply and is protected by a seed coat

____ 7. Tiny stem tip cuttings that were produced through tissue culture techniques; these plants are usually less than one and a half inches tall and must be rooted before being put in the greenhouse

____ 8. Spray nozzle designed to produce a fine mist of water used for propagation

____ 9. The first leaf to emerge during germination; often called a seed leaf because it is part of the embryo inside a seed

a. Leaf bud cutting

b. Callus

c. Cultivar

d. Asexual propagation

e. Cotyledons

f. Sexual propagation

g. Lateral bud

h. Leaf cutting

i. Division

j. Mist nozzle

k. Cutting

l. Microcutting

m. Stem tip cuttings

n. Mist nozzles

o. Plant propagation

p. Rockwood strips

q. Separation

r. Propagation bench

s. Seedling

t. Seed

u. True leaves

v. Oasis

___10. A piece of vegetative plant tissue that when treated properly will regenerate a new plant

___11. A new plant that emerges due to germination

___12. A method of propagation that uses seeds to produce new plants

___13. A method of propagation that uses vegetative tissue to produce new plants

___14. A bench specifically designed to supply mist and heat for propagation purposes

___15. A method of propagation that involves removing newly formed plants from the parent plant

___16. A method of propagation where the parent plant is cut into sections and each section becomes a new plant

___17. A type of propagation that uses a section of the stem that contains the growing point and lateral buds to produce new plants.

OBJECTIVE 2

Discuss propagation benches. Write your answers in the space provided.

1. How wide should a propagation bench be and why?

____

____

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____

____

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____

2. List the three most commonly used heat systems for propagation benches.

3. Why must mist nozzles produce a fine spray of water and not a heavy spray?

4. What is the disadvantage of having the water line and mist nozzles overhead?

5. What does an inline strainer do, and why is it so important?

6. Is there a danger of being electrocuted while working near a propagation bench?

OBJECTIVE 3

Complete statements about selecting propagation containers. Write the correct answers in the blanks.

1. Seeds are usually hand sown in ________________ flats.
2. Automatic seeders use ________________ trays as propagation containers.
3. Large seeds can either be sown in a community flat or ________________ sown in the production containers.
4. Direct sowing eliminates the ________________ of seedlings.
5. Oasis or rockwool strips are used as propagation containers because a propagator can root ________________ plants in a small amount of propagation space.
6. Geranium cuttings can be ________________ rooted in production containers.

OBJECTIVE 4

Select from a list true statements about seed varieties and calculating planting schedules. Write an "X" in the blank before each true statement.

____ 1. A greenhouse grower should keep informed of new seed cultivars being introduced in the market.

____ 2. Seed catalogs and trade magazines are good sources of information on new seed varieties.

____ 3. A plant that receives the AASW award will perform equally well across the entire U.S.

____ 4. A grower should produce a few flats of a new cultivar and see if customers like it before growing it on a large scale.

____ 5. Seed of new cultivars is cheaper than the seed of old cultivars.

____ 6. Printed production schedules for crops grown from seed are scientifically calculated and must be strictly followed.

____ 7. Environmental factors control the actual production time of a crop.

____ 8. Plants produced by direct sowing are salable 7-10 days earlier than a crop that was transplanted from a seed flat.

____ 9. Seed sowing dates are calculated by counting backwards from the desired sale date.

____ 10. If a crop is ahead of schedule the grower can increase the night temperature in the greenhouse to slow the growth rate down.

OBJECTIVE 5

Discuss germination media and seed sowing methods. Answer the following questions in a brief manner.

1. What three things are required to guarantee high rates of seed germination?

2. Name two commercial germination media a grower could purchase.

3. Is light required for germination?

4. Describe how to broadcast seed in a seed flat and how seeds are sown in rows in a community flat.

5. Give the procedure for direct sowing seed in a production container.

6. Why do only a few small greenhouses have automatic seeders?

OBJECTIVE 6

Arrange in order the stages of seed germination. Write a "1" in front of the first stage, a "2" in front of the second, and so on.

____Swelling of the seed occurs and the seed coat breaks open.

____New plant is able to photosynthesize.

____Stored food in the endosperm is digested.

____Seed absorbs water from the medium.

____Cell division begins.

____Enzymes are activated and synthesized.

____Shoot breaks through the medium surface and cotyledons expands.

____Cells begin elongating and radicle emerges from the seed coat.

____Seedling plant emerges with true leaves.

____Viable seed sewn

OBJECTIVE 7

Describe the proper method for transplanting seedlings.

Explain in a step by step manner how to transplant seedlings from a community flat into a flat of cell packs.

OBJECTIVE 8 **Select from a list true statements about preparing seed for storage.** Write an "X" in the blank before each true statement.

____ 1. Properly stored seeds have internal moisture contents of 40-50%.

____ 2. It is generally recommended that greenhouse growers store their own seed.

____ 3. Because seeds are sold in small quantities there is no need to store extra seed.

____ 4. Seeds loose viability as they age.

____ 5. If a grower is going to store seed, the seed should be dampened and placed in an airtight container.

____ 6. Seed should be stored at a temperature between 40 and 50° F and at a humidity content of 40-50%.

OBJECTIVE 9 **Complete statements about producing and maintaining stock plants for asexual propagation.** Write the correct answers in the blanks.

1. Asexual propagation uses ________________ tissue from a parent plant to create new plants.
2. A group of plants grown to provide cuttings for propagation are called __________________________ plants.
3. Stock plants are usually started __________________ months before the propagation date so they will have time to produce cutting material.
4. Pinching of stock plants is done to promote ______________ .
5. If a stock plant becomes infected with a disease it should be ____________________ because cuttings from the plant will spread the disease.
6. The goal of stock plant production is to produce as many ____________________ as possible.
7. Cuttings should not be allowed to set flower buds because they inhibit ____________________ .
8. Stock plants are usually kept for one season and then destroyed. Getting fresh stock plants each year limits the risk of ______________ and they also produce larger numbers of __________ .

OBJECTIVE 10

Discuss preparing to harvest cuttings. Answer the following questions in a complete manner.

1. How would you prepare the mist bench for cuttings to be stuck tomorrow?

2. What special treatments should stock plants receive the day before cuttings are taken?

OBJECTIVE 11

Describe the proper procedure for harvesting cuttings. The basic order for harvesting cuttings is listed below. Give the details of how to complete each step, or any important information about each topic.

- Explain to employees that stem tip cuttings are to be taken.

- Sterilizing solution for hands and knives.

- Harvest cuttings

- Collect cuttings from one cultivar at a time

- Collect some cuttings, stop and stick and then resume taking cuttings

- Dropped cuttings

OBJECTIVE 12

Discuss applying root promoting chemicals. Answer the questions in the space provided.

1. What are the two most commonly used rooting hormones?

2. Why are rooting hormones available in different strengths?

3. Which rooting hormone has the greatest amount of indolebutyric acid - Hormex #3 or Hormex #8?

4. Why is it recommended to pour a small amount of rooting hormone into a saucer and dip cuttings in the saucer?

5. What should you do with the saucer of used rooting hormone when finished sticking cuttings?

6. How would you apply rooting hormone if the grower purchased a liquid hormone?

7. Where should rooting hormone be stored when not in use?

OBJECTIVE 13

Discuss sticking cuttings. Describe how to complete the task.

1. Stick cuttings into Oasis strips.

2. Direct sticking of cuttings in the production containers.

OBJECTIVE 14

Discuss transplanting rooted cuttings. Answer the following questions in the space provided.

1. How long does the rooting of cuttings usually take?

2. Why should the mist be gradually reduced before cuttings are transplanted?

3. Why must synthetic propagating strips be completely buried when the rooted cutting is transplanted?

4. Why are all plants double watered immediately after transplanting?

OBJECTIVE 15

Discuss labeling plants during propagation. Answer the following questions in the space provided.

1. What information should be included on the label when a plant is propagated?

2. Why do some growers prefer to write on the propagation container rather than labels?

OBJECTIVE 16

Discuss the propagation of microcuttings. Answer the following questions in the space provided.

1. What is a microcutting and how does a grower get them?

2. Why are microcuttings so cost effective for a grower?

3. How does a greenhouse grower get microcuttings to form roots?

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OBJECTIVE 17

Discuss propagation by division. Answer the following questions in the space provided.

1. Define division.

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2. Why are variegated sansevieria only propagated by division?

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OBJECTIVE 18 **Select from a list true statements about propagation by layering.** Write an "X" in the blank before each true statement.

____ 1. Layering can only be done in the fall.

____ 2. Air layering lets adventitious roots form on the stem while attached to the parent plant.

____ 3. Rooting hormone is not recommended when air layering.

____ 4. Girdling the stem is the only wounding method that will work on layering.

____ 5. Moist sphagnum moss is packed around the wound of an air layer.

____ 6. The new plant produced by air layering should be removed from the parent plant when roots can be seen in the moss.

NOTICE The following assignment sheets and job sheets are not part of the written test. If these activities have not been completed, check with your instructor.

OBJECTIVE 19 **Design a propagation bench.** SCORE ______

OBJECTIVE 20 **Determine the correct conditions for seed germination.** SCORE ______

OBJECTIVE 21 **Demonstrate the ability to**

a. **Produce a crop from seed.** RATING ______

b. **Produce plants from stem tip cuttings.** RATING ______

c. **Produce plants from leaf bud cuttings.** RATING ______

d. **Produce plants using division techniques.** RATING ______

WRITTEN TEST ANSWERS

PROPAGATING PLANTS IV

OBJECTIVE 1

1. a
2. o
3. u
4. b
5. h
6. t
7. l
8. n
9. e
10. k
11. s
12. f
13. d
14. r
15. q
16. i
17. m

OBJECTIVE 2

1. Six feet or less so employees can easily reach the center of the bench.
2. Propagation mats

   Root zone

   Under bench forced air
3. Heavy mist leaches nutrients from the foliage; it also waterlogs the media.
4. If the line sags it will constantly drip.
5. Filters out dirt; keeps the solenoid from wearing out and the nozzles from clogging.
6. Not if wired properly; 24 volt system cannot electrocute a person.

OBJECTIVE 3

1. Community or seed
2. Plug
3. Direct
4. Transplanting
5. Many
6. Direct

OBJECTIVE 4

1, 2, 4, 7, 8, 9

OBJECTIVE 5

1. Warmth, moisture, and oxygen
2. Redi-earth, metro-mix 200, pro-mix germinating mix, ball germinating mix, jiffy mix
3. Some plants require light to germinate while others require darkness to germinate.
4. Broadcast - randomly scatter the seed and cover with media if needed.

   Rows - mark off rows, sprinkle seed in the rows and cover the rows with media if needed.
5. Fill container with media and dibble holes

   Drop seed into hole

   Close the holes, label container

   Water

   Put in propagation house
6. Expensive to buy and the greenhouse doesn't grow enough plants to justify the machine.

OBJECTIVE 6

3, 10, 6, 2, 8, 4, 7, 5, 9, 1

OBJECTIVE 7

- Observe; transplant when two true leaves are present
- Water seedling before they leave the prop house
- Fill production containers with moist growing media; dibble holes
- Lift clump of seedling with the media attached
- Separate seedlings holding only by the leaves and drop in holes
- Finish the clump
- Compress media; make sure growing point is out
- Water when flat is transplanted

OBJECTIVE 8

3, 4, 6

OBJECTIVE 9

1. Vegetative
2. Stock
3. Four
4. New shoots or branching
5. Discarded or thrown away
6. Cuttings
7. Rooting
8. Disease; cuttings

OBJECTIVE 10

1. Sterilize bench and nozzles
   Check nozzle operation
   Check heat system
   Put propagation container on bench
   Dibble holes if needed
   Turn mist on
2. Water twice
   Spray with a fungicide

OBJECTIVE 11

1. Must have a growing point and no flower buds
   Should be 2-4" in length
2. 10% clorox solution or other greenhouse disinfectant
   Dip hands, forearms and knives
   Redip hands, forearms and knives every 25-30 cuttings
3. Make clean cut
   Does not have to be at a node
   Growing point must be present
4. Eliminates mistakes in labeling
5. Collect 75-100 cuttings at a time
   Quick sticking eliminates wilting of cuttings

6. Throw away dropped cuttings

   Disease quickly spreads on propagation bench

OBJECTIVE 12

1. IBA and NAA
2. Because plants differ in their ability to root; some root easily while others are very hard to root.
3. Hormex #8
4. So the stock container of hormone is not contaminated
5. Throw it away
6. Pour 1" of solution in a beaker or jar

   Gather cuttings, cut end together

   Dip in solution for about 30 seconds

   Shake off excess solution

   Stick cuttings
7. Refrigerator

OBJECTIVE 13

1. Remove lower leaves on cuttings

   Apply rooting hormone

   Push cutting into Oasis enough to hold it upright

   Readjust foliage

   Hand water

   Adjust mist

2. Remove the lower leaves on cuttings

   Apply rooting hormone

   Drop in dibbled holes

   Readjust the foliage

   Hand water

   Adjust mist

OBJECTIVE 14

1. 14-21 days
2. Acclimates the cuttings to the production environment.

   Forces the transpiration system to work.
3. So water is not wicked away from the roots.
4. Destroy air pockets in the media.

   Get media in close contact with the roots.

OBJECTIVE 15

1. Cultivar or species, date propagated and name of propagator if required
2. Eliminates labels being switched or lost

OBJECTIVE 16

1. Tiny stem tip cuttings that are produced by tissue culture.

   Growers order microcuttings from special tissue culture companies.
2. Because lots of cuttings are packaged in a small bag and the shipping cost is very low.
3. Microcuttings are rooted like any other cuttings; treated with rooting hormones and placed on the propagation bench.

OBJECTIVE 17

1. The dividing or cutting up of the parent plant into sections and each section becomes a new plant.
2. They do not produce variegated plants if cuttings are taken.

OBJECTIVE 18

2, 5, 6

OBJECTIVES 19 - 20	Refer to answers to Assignment Sheets 1 and 2.
OBJECTIVE 21	Refer to Practical Test for Job Sheets 1 through 4.

OBJECTIVE SHEET

MAINTAINING PLANT NUTRITION

V

INTRODUCTION

The quality of greenhouse produced plants is dependent upon the nutrition provided by the grower. Improper nutrition can cause pH and soluble salt problems in the media which produces unattractive plants. When proper nutritional levels are used, healthy, attractive plants are quickly produced.

UNIT OBJECTIVE

After completing this unit, the student should be able to correctly calculate and apply fertilizers to greenhouse crops. The student will demonstrate these competencies by completing the assignment sheets, job sheets and written test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. List the essential plant nutrients.
2. Identify how media pH affects nutrient availability.
3. Discuss fertilizer reaction on media pH.
4. Discuss the effect of fertilizers on total soluble salt concentrations.
5. Describe various fertilizing methods.
6. Select from a list true statements about choosing and maintaining fertilizing equipment.
7. Discuss fertilizer and nutrient rates.
8. Calculate fertilizer rates.
9. Discuss monitoring fertilizing equipment and repairing if required.
10. Discuss media tests for nutrient levels.
11. Discuss collecting tissue samples for nutritional monitoring.
12. Select from a list true statements about nutritional deficiency and toxicity problems.
13. Discuss correcting nutritional deficiencies.
14. Calculate fertilizer cost.
15. Discuss maintaining a fertilizer inventory.

16. List the conditions for properly storing fertilizer.
17. Determine the rates of fertilizer needed. (Assignment Sheet 1)
18. Decide which fertilizers are the best buy. (Assignment Sheet 2)
19. Demonstrate the ability to
    a. Check the precision of fertilizer injectors. (Job Sheet 1)
    b. Measure the total soluble salt content of a growing medium. (Job Sheet 2)
    c. Test growing medium pH. (Job Sheet 3)

SUGGESTED ACTIVITIES

MAINTAINING PLANT NUTRITION

V

PREPARATION

- Obtain materials to supplement unit.

  NOTE: See Suggested Resources

- Review instructional outline for this unit. Modify time frames to suit class needs and plan activities for each class period.

- Study the specific objectives to determine those you will cover in your presentation. Decide also which objectives should be taught to which students.

- Determine scope and sequence of objectives that you add. Design and develop support materials, including evaluation techniques, for additional objectives.

- Determine how you will schedule time for students to demonstrate competence in the required procedures.

- Make arrangements for guest speakers. Supply speakers with specific objectives and other appropriate sections of the unit.

- Collect photos or slides of nutrient deficient plants.

DELIVERY

Objectives 1 and 2

- Introduce the topic of maintaining plant nutrition. Stress the importance of proper nutrition in producing healthy plants.

- Discuss plant nutrients. Show pictures or slides of nutrient deficiencies in plants.

- Discuss how media pH affects nutrient availability.

- Demonstrate to students how to use a pH meter.

Objectives 3 and 4

- Discuss fertilizer reaction on media pH.

- Discuss the effect of fertilizer on total soluble salt concentrations.

- Take a sample of fertilizer solution and test its pH and soluble salt content. Explain how the constant application of fertilizer will alter the media pH and salt content.

Objectives 5 and 6

- Discuss various fertilizing methods.
- Discuss choosing and maintaining fertilizing equipment.
- Tour a greenhouse and show students the various methods of fertilizer application and the different pieces of fertilizing equipment.

Objectives 7 through 9

- Discuss fertilizer and nutrient rates.
- Display different types of fertilizers and discuss the advantages and disadvantages of each type.
- Discuss calculating fertilizer rates. Demonstrate to students how to calculate fertilizer rates.
- Have students practice calculating fertilizer rates for different situations.
- Discuss monitoring fertilizing equipment and repairing if required.

Objectives 10 and 11

- Discuss media tests for nutrient levels.
- Discuss collecting tissue samples for nutritional monitoring.
- Have students collect a tissue sample and evaluate the report from a laboratory.

Objectives 12 and 13

- Discuss nutritional deficiency and toxicity problems.
- Discuss correcting nutritional deficiencies.

Objectives 14 and 15

- Discuss calculating fertilizer cost and maintaining a fertilizer inventory.
- Have students practice calculating fertilizer cost.

Objective 16

- Discuss the conditions for properly storing fertilizer.

APPLICATION

Objective 17

- Use Assignment Sheet 1 to give students practice in determining the rates of fertilizer needed.

Objective 18

- Use Assignment Sheet 2 to give students practice in deciding which fertilizers are the best buy.

Objective 19

- Use Job Sheet 1 to allow students an opportunity to check the precision of a fertilizer injector.
- Use Job Sheet 2 to allow students an opportunity to measure total soluble salt content of soilless media.
- Use Job Sheet 3 to allow students an opportunity to test growing media pH.

EVALUATION

Practical Test

- Explain to students that they will be asked to demonstrate procedures on the job sheets to complete the practical test.
- Describe the rating scale used on the practical test.
- Give practical test.
- Reteach and retest as necessary.

Written Test

- Explain to students that they will be asked to demonstrate on the written test actions listed in the specific objectives.
- Give written test.

  NOTE: Written test may be given in sections if desired.

- Evaluate students on assignment sheet activities if not previously done.
- Reteach and retest if necessary.

- Complete appropriate section of competency profiles.

- Review individual and group performance in order to evaluate teaching methods. Adjust scope, sequence, or instructional approaches for additional lessons as required.

SUGGESTED RESOURCES

Publications

Nelson, Paul V., *Greenhouse Operation and Management*, 3rd. ed. Reston Publishing Company, Inc., Reston, Virginia, 1985.

Other Media

- Purchase a pH meter, conductivity meter and a soil testing kit if the greenhouse does not have one.

UNIT REFERENCES

- *A.H. Hummert Seed Company Catalog*, A.H. Hummert Seed Co., St. Louis, Missouri, 1989.

- *Cornell Recommendations for Commercial Floriculture Crops*, Cornell University, Ithaca, New York, 1988.

- Manaker, George H, *Interior Plantscapes Installation, Maintenance, and Management*, 2nd ed., Prentice Hall, Inc., Englewood Cliff, New Jersey, 1987.

- Nelson, Paul V., *Greenhouse Operation and Management*, 3rd. ed., Reston Publishing Company, Inc., Reston, Virginia, 1985.

- Peters Technical Bulletins PTB-113B, PF 106B, PTB 104-E, Grace Sierra, Fogelsville, Pennsylvania.

- Peterson, J.C., "Effects of pH Upon Nutrient Availability In a Commercial Soilless Root Medium Utilized For Floral Crop Production," Ohio Agricultural Research and Development Center Research Circular 268, 1982.

- Tayama, H. K., Extension Slants-Production Pointers, Ohio Florists' Association Bulletin 442:9.

- Troug, E., "Lime In Relation To Availability of Plant Nutrients," Soil Science 65:1-7, 1948.

BASIC ACADEMIC SKILLS

The following table identifies the basic academic skills that are reinforced in this unit of instruction. These basic academic skills were identified using *The Basic/Essential Skills Taxonomy*, 2nd edition, and verified during the validation process.

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 1	Language Arts 013	Applies/Uses	Definitions	
	Science 379	Describes/ Explains	Plants	Fertilization
OBJECTIVE 2	Language Arts 013	Applies/Uses	Definitions	
	Language Arts 139	Comprehends	Information-written	Context
	Science 037	Applies/Uses	Classification schemes	
OBJECTIVE 3	Science 379	Describes/ Explains	Plants	Fertilization
	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
	Science 058	Describes/ Explains	Acids/bases	pH
OBJECTIVE 4	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
	Science 379	Describes/ Explains	Plants	Fertilization
	Science 393	Describes/ Explains	Solutions	Soluble/ insoluble

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 5	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
	Science 378	Describes/ Explains	Plants	
	Science 379	Describes/ Explains	Plants	Fertilization
OBJECTIVE 6	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity
OBJECTIVE 7	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
	Language Arts 088	Composes/ Edits	Reports/ essays	Editorials/ opinions
	Science 379	Describes/ Explains	Plants	Fertilization
OBJECTIVE 8	Mathematics 054	Computes	Expected values	Probabilities/ decimals/ fractions/ percent
	Mathematics 015	Calculates	Percent	In/decrease, markup/ discount
OBJECTIVE 9	Mathematics 127	Converts	Word problems	Mathematical expressions
	Mathematics 229	Solves problems	Generate conclusions	Deductive reasoning
	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 10	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
OBJECTIVE 11	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
	Mathematics 229	Solves problems	Generate conclusions	Deductive reasoning
OBJECTIVE 12	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 013	Applies/Uses	Definitions	
OBJECTIVE 13	Mathematics 229	Solves problems	Generate conclusions	Deductive reasoning
	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
OBJECTIVE 14	Mathematics 127	Converts	Word problems	Mathematical expressions
	Mathematics 073	Computes	Multiplication	Whole numbers
	Mathematics 065	Computes	Multiplication	Decimals
	Mathematics 047	Computes	Division	Whole numbers
	Mathematics 039	Computes	Division	Decimals
	OR			
	Mathematics 262	Uses calculator	Division	
	Mathematics 266	Uses calculator	Multiplication	

	SKILL AREA/ CODE	VERB	LINK A	LINK B
	Mathematics 054	Computes	Expected values	Probabilities/ decimals/ fractions/percent
	Mathematics 021	Calculates/ Evaluates	Price	Unit measure
OBJECTIVE 15	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
	Mathematics 229	Solves problems	Generate conclusions	Deductive reasoning
OBJECTIVE 16	Language Arts 038	Collects/ Organizes	Information-oral/written	
	Language Arts 139	Comprehends	Information-written	
	Science 041	Applies/Uses	Laboratory techniques	Safety
OBJECTIVE 17	Mathematics 127	Converts	Word problems	Mathematical expressions
	Mathematics 232	Solves problems	Proportion	Volume
OBJECTIVE 18	Mathematics 021	Calculates/ Evaluates	Unit measure	Price
	Mathematics 127	Converts	Word problems	Mathematical expressions
	Mathematics 232	Solves problems	Proportion	Volume

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 19a	Language Arts 035	Attends	Directions/task	
	Science 040	Applies/Uses	Laboratory techniques	
	Science 042	Applies/Uses	Maps/Charts/ tables/graphs	
	Science 045	Applies/Uses	Scientific methods	Analysis--qualitative/ quantitative
	Science 049	Applies/Uses	Scientific methods	Problem identification
	Mathemtics 084	Computes	Subtractions	Decimals
OBJECTIVE 19b	Language Arts 035	Attends	Directions/task	
	Science 040	Applies/Uses	Laboratory techniques	
	Science 042	Applies/Uses	Maps/Charts/ tables/graphs	
	Science 045	Applies/Uses	Scientific methods	Analysis--qualitative/ quantitative
	Science 049	Applies/Uses	Scientific methods	Problem identification
	Science 393	Describes/ Expains	Solutions	Soluble/ insoluble
	Science 495	Measures	Temperature	
	Science 496	Measures	Time	F/C
	Science 497	Measures	Volume	Liquids/ solids

OBJECTIVE 19c

SKILL AREA/ CODE	VERB	LINK A	LINK B
Language Arts 035	Attends	Directions/task	
Science 040	Applies/Uses	Laboratory techniques	
Science 045	Applies/Uses	Scientific methods	Analysis--qualitative/ quantitative
Science 049	Applies/Uses	Scientific methods	Problem identification
Science 058	Describes/ Explains	Acids/ bases	pH
Science 496	Measures	Time	F/C
Science 497	Measures	Volume	Liquids/ solids

INFORMATION SHEET

MAINTAINING PLANT NUTRITION

V

OBJECTIVE 1

List the essential plant nutrients.

Seventeen elements are required to support plant growth. Without these nutrients plants grow abnormally and eventually die.

- All elements except Carbon, Hydrogen, and Oxygen must be supplied to the plant through the growing medium.
- Because the growing medium is largely soilless there are very few nutrients available from the medium; it must be supplied by fertilizers.
- Some nutrients are required in large amounts by the plant; they are called macroelements. The nutrients required in small amounts are called microelements. The terms micronutrient and trace element are often used interchangeably for microelement.

Nutrient	Chemical	Classification
Carbon	C	Nonfertilizer
Hydrogen	H	Nonfertilizer
Oxygen	O	Nonfertilizer
Nitrogen	N	Macronutrient-primary
Phosphorus	P	Macronutrient-primary
Potassium	K	Macronutrient-primary
Calcium	Ca	Macronutrient-primary
Magnesium	Mg	Macronutrient-primary
Sulfur	S	Macronutrient-primary
Iron	Fe	Micronutrient
Manganese	Mn	Micronutrient
Zinc	Zn	Micronutrient
Copper	Cu	Micronutrient
Boron	B	Micronutrient
Molybdenum	Mo	Micronutrient
Sodium	Na	Micronutrient
Chloride	Cl	Micronutrient

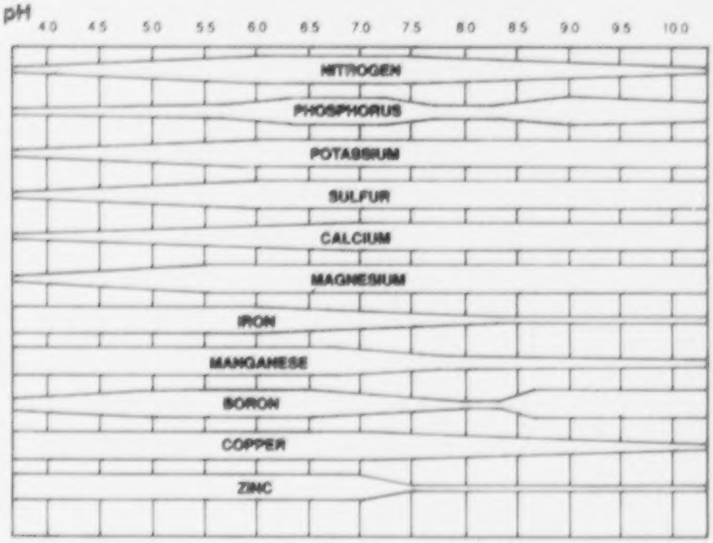
OBJECTIVE 2 **Identify how media pH affects nutrient availability.**

- Plant nutrients are commonly applied to the growing media as a solution. As the solution drains through the media the elements become weakly attached to the media particles.

- As the pH of the media and its solution changes, the strength of the ion availability changes.

- When the pH is in the acid range some elements bond with phosphorus and become unavailable to the plant while other elements become soluble and may cause toxicity problems.

Availability Scale



- Raising the pH to alkaline levels causes calcium and magnesium to become extremely available, but trace elements are deficient.

- Ideally a soilless media pH should be kept in the 5.5 to 6.2 range.

OBJECTIVE 3 **Discuss fertilizer reaction on media pH.**

- Fertilizers tend to change the media pH and a grower must be aware of what is happening to the pH.

- Knowing a fertilizer is going to lower the pH helps the grower decide how much lime to incorporate into a growing media while it is being mixed. The lime should cancel the expected decrease in pH due to the fertilizer. However, the media still has a tendency to change during the growing cycle.

- The media should be tested frequently during the production cycle so the grower is aware of the pH changes. Often the pH shift can be halted by switching to a fertilizer with a different reaction. For example, the media pH has been dropping so the grower switches to calcium nitrate as the fertilizer source. Calcium nitrate has a tendency to raise the pH and the decreasing pH should be controlled.

- Unfortunately, the media is not always monitored as it should be and severe changes occur. When these changes cause physiological problems on the plants the grower then checks the pH. Quick action must be taken to relieve the nutrient problems. Fertilizers are moderate to slow in altering pH and cannot be used as a quick remedy. When a quick pH change is needed a grower must apply drastic methods.

- If the pH is too low, hydrated lime (builders lime) may be used to raise the pH. This material can be applied dry to the media surface at a rate of 1.5 pounds per 100 square feet. If lime is applied directly on the plant, injury may result. Immediately water the lime in and wash off the foliage. The hydrated lime can be mixed with water and the solution poured onto the media. Dissolve 1 pound in 5 gallons of water; not all the lime will dissolve so it precipitates to the bottom. Pour the solution, and not the precipitate, onto 20 square feet of media surface. Hydrated lime reacts quicker than dolomitic limestone and should quickly raise the pH. If necessary, the treatment can be reapplied in three weeks.

- To lower the pH of the media use aluminum sulfate or iron sulfate. These products are soluble in water and may be applied as a drench. They work rapidly because they are converted to sulfuric acid in the media. When applying these materials, be careful not to lower the pH too much.

OBJECTIVE 4

Discuss the effect of fertilizers on total soluble salt concentrations.

All fertilizers are salts, and if they are misused the grower will have problems with the total soluble salt concentration of the growing medium.

- Total soluble salt concentration is a measure of all ions that are dissolved in the medium solution. These minerals come from the medium, the fertilizer, and the water used to irrigate the plants. Sodium, calcium, magnesium, potassium, nitrates and sulfates are common components of the total soluble salt concentration.

- Soluble salt readings can be used to indicate the level of nutrition present in the medium. A low soluble salt reading may indicate a lack of nutrition while excessive soluble salt concentrations can indicate excess rates of fertilizers.

- A normal total soluble salt concentration of 1.0 to 1.5 millimhos/cm is ideal for a peat lite medium. Use the following chart to interpret total soluble salt concentrations.

Interpretation of total soluble salts test

Total soluble salts* (Solu-bridge readings .K x 10^{-5})		Rating	Interpretation
Mineral soil	Peat-lite mix		
Above 200	Above 350	Excessively high	Plants may be severely injured.
176-200	225-350	Very high	Plants may grow adequately, but range is very near the danger zone and injury may occur, especially if soil dries.
126-175	176-225	High	Satisfactory for established plants. The upper level may be too high for seedlings or newly planted cuttings.
51-125	100-175	Medium	Satisfactory for general plant growth. Excellent range for plants fertilized at every watering.
0-50	0-100	Low	A low soluble salt content does no harm, but may indicate very low nutrient content.

*The concentration of soluble salts is determined electrically with a Solu-bridge instrument. Readings reported by the Floriculture Soils Laboratory at Cornell University are K x 10^{-5}, a measure of electrical conductivity. Other laboratories may report results in millimhos per cm. Convert millimhos per cm to k x 10^{-5} by moving the decimal point 2 places to the right, e.g., 2.50 millimhos per com = 250 K x 10^{-5}. For mineral soils the Floriculture Soil Testing laboratory uses 1 part dry soil and 2 parts water; for peat-lite mixes a level tbsp or dry mix and 40 ml of water give an equivalent 1:2 volume-ratio.

Courtesy of Cornell University, *Cornell Recommendations for Commercial Floriculture Crops, Part 1: Cultural Practices and Production Programs*

- Causes of high total soluble salts may be due to:
  - Applying excessive rates of fertilizer.
  - Not applying enough water to completely wet the rooting medium when the plants are watered.
  - Subirrigation watering method.
  - Poor drainage of the growing medium.
  - Water that has high levels of salts.
- Excessive levels of soluble salts can be reduced by:
  - Leaching with plain water. Thoroughly water the crop with plain water, wait 30 minutes and water again. The first application of water dissolves the salts and the second application washes them out of the medium.
  - Applying moderate rates of fertilizers at frequent intervals.
  - Applying water at rates that allow a small amount of solution to drip from the production container.
- Symptoms of salt injury are:
  - Wilting of the plant; roots are unable to take up water.
  - Chlorosis and leaf drop.
  - Burning of the leaf margins and tips. This usually appears near the growing point of the plant first.
  - Browning and dying of the roots.

OBJECTIVE 5

Describe various fertilizing methods.

A grower can choose to apply fertilizer in several different ways. Any of these methods can be used but careful attention must be paid to the nutrient levels.

- Slow release fertilizers can be incorporated into the growing medium or applied as a topdressing to the container. These methods were discussed in unit 2.

- Because clear water is used to irrigate plants on a slow release fertility program, no specific fertilizing equipment is required.

- Many growers feel that slow release fertilizer programs do not waste fertilizer since only a portion of the dissolved fertilizer drips from a container while being irrigated.

- Liquid fertility programs may be used once a week, or at every watering - constant liquid feed (CLF).

- Weekly liquid fertility programs apply a high rate of nutrients one day a week and clear water the rest of the week. A constant liquid feed program supplies moderate levels of nutrients all the time.

- Some growers feel that weekly fertilizing starves the plants for a few days and then over fertilizes them the rest of the time. They feel that a CLF program supplies the plant with optimum levels of nutrients all the time.

- A few growers choose to combine the liquid and slow release methods. They will incorporate half rates of slow release fertilizers and then supplement with liquid fertilizers. This method allows the grower to quickly raise or lower the rates of fertilizer; it provides them with the ability to fine tune the fertility program.

- CLF and slow release programs can easily be used with automatic watering systems or hand watering.

- A constant liquid feed program does require more equipment and maintenance than a slow release program.

OBJECTIVE 6

Select from a list true statements about choosing and maintaining fertilizing equipment.

A constant liquid feed program requires some method of mixing the liquid fertilizer solution.

- Liquid fertilizer can be applied by hand to the crop. The fertilizer would be diluted to the desired strength and poured on each container with a cup. Needless to say this is labor intensive and only practical for small sized specialty crops; for example, hand applying liquid fertilizer to a capillary mat watering system on a bench of African violets.

- Most growers use an injector to mix a concentrated fertilizer solution into the water line. When this concentrate is mixed with clear water the desired rate of fertilizer solution is created.

- Since liquid fertilizer is in the water line it can easily be run through an automatic watering system.

- There are many different injectors a grower can choose to use for fertilizing. They range in price from $10 to several thousands depending on their capabilities. Below is a brief description of the most common fertilizer injectors.

  - Hozon—A small brass mixing valve that screws onto the faucet and has a hose attached to it. As water passes through the Hozon it creates a suction that draws fertilizer from a concentrate tank. The Hozon is inexpensive, about $10, and it works well for a small operation. It is limited to a flow rate of 3 gpm, (gallons per minute) and has a proportioning ratio of 1:16; for each gallon of concentrate used it produces 16 gallons of liquid fertilizer solution. The accuracy of the proportioning depends on the flow rate of the tap water. The Hozon requires very little maintenance; check the screen on the suction line for clogs and periodically remove the salt deposits from the mixing valve.

    The major limitation to the Hozon is the small proportioning ratio. With a small ratio a huge concentrate tank would be needed to fertilize a large greenhouse.

  - Commander Proportioner—A water driven pump that injects fertilizer concentrate at a ratio of 1:128. It has a maximum flow rate of 7 gpm and has an all-hydraulic pump. Since it has a large proportioning rate it is feasible for moderate sized greenhouses to use. The cost is about $250. Maintenance requires keeping the intake screen clean and flushing the concentrate line when finished using.

    This proportioner operates best if it is permanently mounted in the greenhouse. If it is used as a portable unit there may be problems with vapor lock in the lines.

  - Gewa—This injector has no suction or pumping device. The fertilizer concentrate is forced into the water line by the pressure of the water. The concentrate is poured inside the Gewa into a plastic membrane and the lid is sealed shut. When the tap water is turned on it surrounds the membrane and begins to squeeze the bag; this forces a calibrated amount of concentrate into the water line. The Gewa is available in several different sizes from 4 gallons to 26 gallons. Depending on the model it has proportioning ratios of 1:100 up to 1:300. Gewas are made with wheels and are easily moved from one house to another. The price ranges from $700 to $1500.

The maintenance on a Gewa is higher than the other injectors. Periodically the inner membrane must be replaced and that requires disassembling the unit. Caution must be used when opening and closing the Gewa so the top cover is not improperly closed or bent. It must seal perfectly for the unit to work correctly.

This fertilizer injector for moving to multiple locations.

- Smith injectors—Large bronze and stainless steel units that are permanently set at proportion ratios of 1:100 or 1:200. These units are designed to inject fertilizer for an entire greenhouse range; they have flow rates of up to 100 gpm. Prices range from $1200 to $2500. These injectors have a history of being very accurate and dependable. There is virtually no maintenance other than flushing the fertilizer out of the machine after each use.

  One drawback to the Smith injector is that if it malfunctions, or is inaccurately proportioning, it must be sent back to the factory for repairs.

- There are many other proportioners and injectors available. Talk with company representatives or other growers who are familiar with the equipment before purchasing a unit.

- All liquid fertilizer injectors and proportioners operate best if the concentrate tank is kept clean and free of dirt and debris. Once dirt or undissolved fertilizer is inside the injector the proportioning ratio will be incorrect. Place a cover or lid on the concentrate tank to keep the solution clean.

OBJECTIVE 7 **Discuss fertilizer and nutrient rates.** (Supplement 1)

The choice of fertilizers will depend on the method of fertilization. Different kinds of fertilizers are used for dry and liquid feeding programs.

Selecting fertilizers

- Slow release fertilizers can be purchased in many analysis with different lengths of activity.

Fertilizer	Activity period
Osmocote 14-14-14	3-4 months
Osmocote 19- 6-12	3-4 months
Osmocote 13-13-13	8-9 months
Osmocote 18- 6-12	8-9 months
Osmocote 17- 7-12	12-14 months
Osmocote 40- 0- 0	9 months
Osmocote 39- 0- 0	9 months
Osmocote 17- 9-13	2-3 months
Sierra 17- 6-10	8-9 months
Sierra 17- 6-12	3-4 months

- Water soluble complete fertilizers are available from many companies; Peters Soluble fertilizers, Dyna Green Professional fertilizers, Master Blend Soluble fertilizers are only a few of these available. They can be purchased in numerous analysis and are available in crop specific formulations.

  These fertilizers usually contain all the macroelements and microelements a crop will need. They are commonly used because they are so easy to use. They dissolve in water, are ready to use, and are very accurate. They are, however, an expensive form of fertilizer.

- Mix your own water soluble fertilizer using common fertilizer carriers such as ammonium nitrate and potassium nitrate. These carriers can be combined to make excellent liquid fertilizers and it is relatively inexpensive to do. However, the greenhouse must have employees who are skilled enough to be able to calculate the fertilizer rates and reliably mix the material. Also, close nutritional monitoring must be done to ensure that adequate amounts of trace elements are available.

  This type of fertility program is useful for the experienced grower; it is usually not for the beginning or inexperienced grower.

- When deciding what type of fertilizer to use a grower should consider cost of the fertilizer, the ease of using the material, what nutrients it will supply and how foolproof it is. Saving $25 on fertilizer for a crop of geraniums is no savings if the crop fails due to lack of trace elements.

- When mixing your own fertilizer concentrates do not mix calcium with a sulfate or phosphate material. The calcium will precipitate out and the concentrate is unusable.

- Fertilizer carriers also change the medium pH. Use ammonium nitrate when the pH needs to be lowered and calcium nitrate to increase the pH. Commercial water soluble fertilizers also alter the pH; literature on the product will give the reaction for the fertilizers.

- The source of nitrogen will affect plant performance. Nitrogen is available in an ammonium form (NH_4^+) or a nitrate form (NO_3^-). Plants generally prefer the nitrate form but use ammonium to a small degree. Most fertilizers contain both forms of nitrogen and the analysis will tell what percent of each is available.

- Crops grown in soilless media perform poorly if more than 35% of ammonium nitrogen is present. Fertilizer companies now sell peat-lite fertilizers that contain a majority of the nitrogen in the nitrate form; these fertilizers were developed to eliminate the ammonium toxicity problems in soilless media.

Selecting fertilizer rates

The fertilizer rate will depend on the crop being grown. Some crops are light feeders and require only 75-100 ppm N while others are heavy feeders and may need 300 ppm N.

- Any reference book on floriculture crops will provide information on specific crop nutrition; trade magazines are also good sources of information. Every greenhouse should have a reference book on floriculture production available for employee use.

- Most crops respond to equal amounts of nitrogen and potassium; 20-10-20 peat-lite special fertilizers are very popular materials that supply equal portions of nitrogen and potassium.

- Fertilizer recommendations are usually given as ppm (parts per million), or ounces/100 gallons. A typical greenhouse fertilizer rate is 200 ppm N and K_2O. This rate is usually satisfactory on a wide range of crops until specific information can be found.

- Crops may be classified as light, moderate or heavy fertilizer users. The following chart gives guidelines for crop nutrient requirements.

Light	Moderate	Heavy
violets	bedding plants	mums
gloxinias	roses	poinsettia
ferns	geranium	
foliage	pot plants	
bulbs		
75-125 ppm N	200- 250 ppm N	300 ppm N

- Crop requirements for fertilizer change as the plants mature. This often requires a grower to switch to a different fertilizer towards the end of the production cycle; plants require less nutrients as they mature.

OBJECTIVE 8

Calculate fertilizer rates.

- Every greenhouse employee should be able to calculate how much fertilizer is needed to make a desired solution.

- To calculate the amount of fertilizer needed use the formula below.

$$\frac{(\text{ppm desired})(\ 1.33\ )}{\%\ \text{nutrient in fertilizer}} = \text{ounces fertilizer/ 100 gallons}$$

Multiply the desired ppm by 1.33 and divide the number by the percent of the element in the fertilizer. The result is the number of ounces of fertilizer needed to make 100 gallons concentrate solution.

- Determine how much Peters 20-10-20 peat-lite is needed to make a 175 ppm N solution.

$$\frac{(175)(1.33)}{20} = 11.6 \text{ oz. Peters /100 gallons}$$

- When using injectors, the fertilizer must initially be made into a concentrated solution so the injector can dilute it according to its proportioning ratio. The previous calculation will be used to determine how to make concentrate for the various injectors.

  - Gewa proportions at a 1:100 ratio

    Since the formula gives the rate for 100 gallons, 11.6 oz. of Peters must be dissolved in enough water to make 1 gallon of concentrate.

    When the concentrate is sucked up by the Gewa and mixed with water the fertilizer solution coming out of the hose will be 175 ppm.

  - Hozon proportions at a 1:16 ratio

    Since the Hozon only produces 16 gallons of fertilizer solution for every 1 gallon of concentrate, the amount of fertilizer must be calculated for 16 gallons.

    $$\frac{11.6 \text{ oz}}{100 \text{ gal}} = \frac{X}{16 \text{ gal}}$$

    $$\begin{aligned}(11.6 \text{ oz})(16 \text{ gal}) &= (X)(100 \text{ gal}) \\ x &= 1.9 \text{ oz}\end{aligned}$$

    1.9 oz of Peters must be mixed with each gallon of water to make the concentrate for a Hozon injector.

  - Commander proportions at a 1:128 ratio

    The commander makes 128 gallons of fertilizer solution from each 1 gallon of concentrate. The amount of Peters must be calculated for this injector.

    $$\frac{11.6 \text{ oz}}{100 \text{ gal}} = \frac{X}{128 \text{ gal}}$$

    $$\begin{aligned}(11.6 \text{ oz})(128 \text{ gal}) &= (X)(100 \text{ gal}) \\ 14.8 \text{ oz} &= X\end{aligned}$$

    Each gallon of concentrate for the Commander injector will have 14.8 oz of Peters dissolved in it.

- This same formula is useful when mixing your own fertilizers. It is a little more complicated because some fertilizers may supply several nutrients which must be accounted for.

  A grower decides they want to make their own 200 ppm N and K_2O fertilizer solution using ammonium nitrate and potassium nitrate. How much of each fertilizer carrier is needed?

  KNO_3 = 13-0-44 NH_4NO_3 = 34-0-0

  $$\frac{(200 \text{ ppm } K_2O)\ (1.33)}{44} = 6.05 \text{ oz } KNO_3/100 \text{ gal}$$

  Using 6.05 oz of KNO_3 will supply 200 ppm K_20 but it also supplies some nitrogen, but how much? The same formula can be used to determine the ppm N supplied by the KNO_3.

  $$\frac{(X \text{ ppm N})\ (1.33)}{13} = 6.05 \text{ oz}/100 \text{ gal}$$

  x = 59.1 ppm N will be supplied by the KNO_3

  Since only 200 ppm N is desired and 59.1 ppm comes from the KNO_3, NH_4NO_3 must supply 140.9 ppm.

  $$\frac{(140.1 \text{ ppm N})\ (1.33)}{34} = 5.5 \text{ oz } NH_4NO_3/100 \text{ gal}$$

  By mixing 6.05 oz KNO_3 and 5.5 oz NH_4NO3 per 100 gallons, a 200 ppm N and 200 ppm K_2O solution is produced.

OBJECTIVE 9

Discuss monitoring fertilizing equipment and repairing if required. (Supplement 2)

- It is advisable to periodically check the fertilizer solution coming out of the injector to see if it is being accurately mixed.
- Undissolved fertilizer or dirt that is picked up by an injector can cause it to inaccurately mix the fertilizer solution.
- Always keep a lid on the concentrate tank. Try not to let the injector suck the concentrate tank dry; dirt settles to the bottom of the tank and will clog the proportioning valve.
- Most injectors have a fine mesh screen on the end of the suction hose. Frequently wash the dirt from the screen so the injector can easily pull in the concentrate.

- To test the accuracy of your injector when using Peters fertilizers:

  1. Collect a beaker of fertilizer solution from the hose.
  2. Test the soluble salt content of this solution with a conductivity meter.
  3. Test the soluble salt content of the tap water used.
  4. Subtract the tap water reading from the fertilizer solution reading. This number is the conductivity due only to the fertilizer.
  5. Using Supplement 2 find the Peters fertilizer you are using across the top; go down that column until you find the number matching your conductivity reading (use the number closest to your reading). Follow that row across to the left hand column; this is the ppm N of the solution.
  6. The chart says there is a +/- 10% error. If your reading is within 10% of the table reading your fertilizer injector is accurately mixing the fertilizer solution.

- If your solution is off the target there is an error in your fertilizer preparation somewhere. The fertilizer rates may have been incorrectly calculated, the fertilizer may have been weighed out improperly or the injector may not be working properly.

- Go back and recalculate the amount of fertilizer needed. Check this number against the previous calculation and see if this is where the error is. Talk with the person weighing the fertilizers and ask them how much they have been weighing out. Do they know how to correctly use the scale?

- If no error has been found, the problem must be with the injector. Chances are the screen or proportioning valve is clogged. Cleaning procedures will depend on the injector used.

- **Hozon**—Thoroughly clean the screen on the end of the suction hose. The brass valve may be soaked in food grade phosphoric acid.

  NOTE: Hozons are very sensitive to water pressure; if the pressure is too high or too low the mixing ratio is not 1:16. Install a pressure gauge and be consistent with the pressure used.

- **Commander**—Clean the screen on the suction line. The pump may have a partial vacuum and need to be primed. If this doesn't solve the problem talk with a company representative.

- **Gewa**—The pinhole inlet or screen is clogged. Disassemble the proportioning valve and soak brass parts in food grade phosphoric acid. Wash screen and remove dirt.

  If the water coming out of the drain valve at the bottom of the unit is blue, there is a tear in the membrane and the fertilizer concentrate is leaking out. This will cause the Gewa to improperly proportion fertilizer. However, if the water coming out the drain is clear, the membrane is good.

- **Smith**—Clean the screen on the suction line. Back flush the lines to remove air vacuums. If this does not correct the problem check with the Smith company.

OBJECTIVE 10 **Discuss media tests for nutrient levels.** (Activity Sheet 1)

Media testing is commonly done to measure the approximate levels of nutrients contained in the media. It is not an accurate measure of the nutrients within a plant since plants cannot immediately absorb nutrients from the media.

- A media test should always be done in conjunction with a media pH and soluble salts test. These three pieces of information give the grower a good idea of where the problem is and how to correct it.

- Media tests can be conducted by the grower at the greenhouse or sent to a commercial lab for analysis.

  Testing at the greenhouse—Many inexpensive soil testing kits are available to the grower; Simplex soil test kits sell for about $200.

  - The kit allows the grower to quickly test nutrient levels and detect major nutritional problems.

  - Results from the kits are approximate ranges and should only be used as rough guidelines.

  - Greenhouse soil testing kits help the grower find major errors in the nutrition programs.

  Commercial laboratory testing—Can be done at many commercial labs across the United States; usually each state has a soil testing lab at the land grant university.

  - Results of a media test from commercial labs are more precise because they have sophisticated equipment to test the sample.

  - Labs usually send the grower a written nutrient analysis report and suggest changes in the nutrition program to correct the problems.

  - Most commercial labs will have the tests completed and results in the mail within 72 hours of receiving the sample. Many growers prefer to send the sample via an overnight or next day delivery; samples arrive faster and will be tested quickly.

  - A fee of $20-30 per sample is normal; this includes a pH, soluble salts and nutrient analysis report, and suggested remedies.

- Growers generally wait until they have a severe problem before they have the media tested. This can be disastrous if a crop is almost completed and a major nutrient toxicity occurs. Commercial labs recommend a crop be tested every 2-4 weeks during production; however, many growers feel that this is too often. Testing a crop at least three times during the production schedule will usually be sufficient.

- The media sample being tested should be representative of the crop, or the problem.

  - Collect a sample from at least 8-10 pots and mix these samples together; if growing in beds collect the samples from eight different areas.

  - If the crop has been topdressed with slow release fertilizer, scrape away the fertilizer and the top one inch of media before taking the sample.

  - A soil sampling tube is made especially for greenhouse crops and is inexpensive to purchase. This tool will collect a core sample from the top to the bottom of the growing medium.

  - Allow the sample to air dry for one day and then place it in a plastic bag or a media testing envelope. Complete the required forms; be as specific as possible. The information sheet helps the lab detect problems and recommend solutions.

  - Send the sample to the lab.

- Keep in mind the media sample should be representative of the crop; if poinsettias are growing in two different media don't mix the media and send one sample, send a sample from each media.

- When testing media with your own kit, follow the recommended sample collection procedures in the instruction manual.

OBJECTIVE 11 **Discuss collecting tissue samples for nutritional monitoring.**

- Analysis of plant tissue is done to determine the actual nutrient content of the plant tissue.

- A plant tissue analysis and media analysis test should be done at the same time. A nutrient deficiency in the plant tissue may be caused by a deficiency of the nutrient in the media or by excessive amounts of another nutrient.

Relationship of Elemental Excess in Growing Media to Potential Nutrient Deficiencies in Tissue

Element in Excess in Media	Element Possibly Deficient in Tissue
N	K
K	N, Ca, Mg
P	Cu, Fe, Zn
Ca	Mg, B
Mg	Ca, K
Na	K, Ca, Mg
Mn	Fe, Mo
Fe	Mn
Zn	Mn, Fe
Cu	Mn, Fe, Mo
Mo	Cu
NH_4	Ca, Cu

Used with permission of Grace Sierra.

- Samples should be collected at least three times during the production cycle. Be consistent on sampling procedure; same day of the week at the same time of day.

- Collecting a leaf sample for tissue analysis is dependent upon the plant species.
  - Usually a sample can be collected at anytime during the production cycle, and the topmost two recently matured leaves with petioles are the desired sample. Occasionally, other plant tissue is preferred.

Tissue Sampling Instructions for Selected Greenhouse Crops

Plant	Sample Type Suggested	Suggested Sampling Time
Azalea Chrysanthemum Easter Lily Gardenia Geranium	Topmost two recently-matured leaves	Anytime
Carnation	5th & 6th leaf pair from tip of non-budded shoot. For Baron, leaves and stems of top 6 inches of budded or flowering shoot	Anytime
Cucumber	Mature leaf near base of main stem	1 week before first fruit set to 3 weeks before harvest
Foliage Plants	Recently-matured leaf	Anytime
Lettuce	Recently-matured leaf and petiole	3 weeks after planting to 1 week before harvest
Poinsettia	Topmost two recently-matured leaves	During production and finishing
Tomato	Leaf and petiole immediately below most recently opened blossom cluster of green, golf-ball-sized fruit	During Production
Roses	Topmost two, fully-expanded, 5-leaflet leave on shoot with bud in color	Anytime

Used with permission of Grace Sierra.

- Do not collect leaf samples if the foliage is wet.
- Leaf samples should be placed in a tissue analysis sample mailer or a paper sack; do not put leaf samples in plastic bags.
- Fill out the information sheet and be as specific as possible.
- Mail the samples, media and tissue to the lab.

- After the tests are completed a printed report will be sent to the grower along with recommendations.

OBJECTIVE 12 **Select from a list true statements about nutritional deficiency and toxicity problems.**

- Every greenhouse will be faced at some time with damaged foliage on a crop. It is the job of the grower to determine the cause of the symptoms; insect, disease, mechanical, spray or nutritional.
- Each nutrient will display characteristic deficiency symptoms that help the grower identify the problem.

Symptoms of Nutritional Deficiencies

NOTE: Nutritional problems may interact to produce these symptoms. Toxic means poison; toxicity means a dangerous level of poison.

ELEMENT	DEFICIENCY SYMPTOMS
MACRONUTRIENTS	
Nitrogen	Leaves become light green and growth is stunted. Plant begins to yellow at bottom while top remains green. Yellowing begins at leaf tip and works back to the petiole. **NOTE:** Symptoms of nitrogen toxicity are: Plant produces all leaves and stems; does not flower or fruit; heavy application may cause top burn.
Phosphorus	Internodes are short; foliage turns purple or dark green. Older leaves die, flowering is poor
Potassium	Stems are weak; leaf tips show brown areas; foliage may be mottled. Fruit is small and shriveled.
SECONDARY NUTRIENTS	
Calcium	Young leaves turn yellow and then brown. Stems are weak, growth is stunted. Growing tips bends.
Sulfur	Lower leaves are yellow; stems and roots are narrow; stems are brittle and break easily.
Magnesium	Leaves are yellow between veins of leaf; yellowing begins at bottom of plant. Leaves are thin and tend to curl upward. **NOTE:** Strong light causes Mg deficiency.
MICRONUTRIENTS	
Iron	Young leaves are yellow between veins while veins remain green. Symptoms appear first on new growth. **NOTE:** High levels of Mn may cause Fe deficiency.

ELEMENT	DEFICIENCY SYMPTOMS
Manganese	Plant growth is stunted; leaves have white spots appearing between veins. Leaves have dead spots.
	NOTE: Strong light may cause Mn deficiency.
Zinc	Buds are poorly formed; new growth is very small and clustered at end of stem. Leaves have dead areas.
Copper	New growth dies back. Leaves have a bleached appearance.
Boron	Tip of growing point dies; buds are light green, no flower formation. Roots have brown center.
	NOTE: Amount of boron is critical; toxicity causes instant death.
Molybdenum	Plant is very stunted; displays overall pale appearance; turning yellow.
	NOTE: Strong light may cause Mo deficiency.

- Mobile elements will show deficiency symptoms in older foliage first; the deficient nutrient will be transported from mature foliage to newly expanding foliage.
- Nonmobile nutrients will display deficiency symptoms in the newly expanding foliage and growing points.
- If a deficiency is suspected, test the media at the greenhouse. An excess amount of an antagonistic element may be present.
- Collect a media and tissue sample and send it to a commercial lab for analysis. If the problem is critical you may want to call the lab and discuss the problem. Most labs are extremely helpful during critical situations.
- A nutrient toxicity is harder to diagnose by visual observation; toxicities usually appear as a deficiency of a different nutrient.

  When trying to identify a nutrient toxicity, a tissue analysis and media analysis must be done at a commercial lab. Greenhouse test kits are not accurate enough to diagnose the levels of trace elements present.

Once the toxic element has been identified the source of contamination must be found. Often excessive levels of trace elements are present in the irrigation water; have the water analyzed for nutrients. Inexpensive, low quality fertilizer carriers are often contaminated with excessive amounts of micronutrients; have the fertilizer solution analyzed and determine if this is where the high levels of a nutrient are coming from. If the pH of the growing medium is out of the ideal range certain elements become available in excess amounts; monitor pH and keep it in the desirable range.

OBJECTIVE 13 **Discuss correcting nutritional deficiencies.**

- After the media and tissue analysis report is received the grower must be able to implement the recommended changes, or use an alternate method to correct the nutrient problems.

- Correcting nutrient problems can usually be done by switching fertility programs or by making a one time application of a special compound.

- First time growers should follow recommended correction procedures from the commercial labs. These labs will consult over the phone with the grower and are anxious to help solve the problem.

- Use extreme caution when trying to correct a micronutrient deficiency; toxicities of these elements are very difficult to correct since they cannot usually be leached from the media.

OBJECTIVE 14 **Calculate fertilizer cost.**

- The cost of purchasing fertilizer is a major part of the cost of producing a crop. Being able to calculate the actual cost of the nutrients allows the grower to compare fertilizers and buy the most economical type. Keeping an accurate fertilizer inventory ensures that the greenhouse won't run out of fertilizer and tells the grower how much fertilizer is used each month. Advanced, or offseason purchasing can be done at reduced cost.

- The cost of soluble fertilizers are usually calculated on the cost of a ppm nitrogen solution. The steps below show how to calculate fertilizer cost.

  1. Determine the cost per ounce of fertilizer carrier.

     Peters 20-10-20 cost $20.70 for 25 pounds

     $$\frac{\$20.70}{25\text{ lb.}} = \frac{\$.828/\text{lb.}}{16\text{ oz./lb.}} = \$.052/\text{oz.}$$

     Calcium nitrate cost $13.95 for 50 pounds

     $$\frac{\$13.95}{50\text{ lb.}} = \frac{\$.279/\text{lb.}}{16\text{ oz./lb.}} = \$.017/\text{oz.}$$

  2. Determine how much fertilizer is needed to make 100 gallons of the desired ppm N solution.

     Make a 200 ppm N solution

     $$\frac{(200\text{ ppm N})\ (1.33)}{20} = 13.3\text{ oz. Peters}$$

     $$\frac{(200\text{ ppm N})\ (1.33)}{15.5} = 17.16\text{ oz. }CaNO_3$$

  3. Calculate the cost of 100 gallons of fertilizer solution; multiply the cost per ounce by the number of ounces required.

     (13.3 oz/100 gal)($.052/oz) = $0.69/100 gal 200 ppm N solution using Peters

     (17.16 oz/100 gal) ($.017/oz) = $0.29/100 gal 200 ppm N solution using calcium nitrate

  4. These same calculations can be used to calculate the cost of P_2O_5 and K_2O.

- Slow release fertilizers are calculated on a cost per pot basis. A specific number of grams is applied to a pot when Osmocote is used, and the cost per pot can be calculated.

  1. Determine the cost per gram of the carrier.

     Osmocote 19-6-12 cost $44.35 for 50 pounds

     $$\frac{\$44.35}{50\text{ lb.}} = \frac{\$0.89/\text{lb.}}{454\text{ gm/lb.}} = \$.0019/\text{gram}$$

2. Find the recommended rate for the crop being produced.

   Osmocote 19-6-12 is applied at a rate of 9 grams per 6" pot for mums.

3. Multiply the rate by the cost/gram and this yields the cost/pot.

   (9 grams/6"pot) ($.0019/gram) = $.017/6" pot

- When trying to compare a liquid fertilizer program to a slow release program, the cost of the fertilizer for the entire crop production period must be calculated. The example below compares using Peters and Osmocote to produce 5" geraniums.

  The required fertilizer rate for Peters 20-10-20 is 200 ppm N, and Osmocote 19-6-12 is 3 grams per 5" pot. The production period will be 10 weeks and it is estimated the plants will be watered every day. The volume of water or fertilizer solution applied to the container is equal to the pot size; 5" pot gets 5 ounces water, 8" pot gets 8 ounces water, etc.

1. Calculate the cost of each fertilizer carrier based on the smallest unit of,measure.

   200 ppm N solution of Peters cost $.69/100 gal

   Osmocote 19-6-12 cost $.00[illegible]/gram

2. Calculate cost per pot for the production cycle.

   Peters will be applied at every watering

   (10 weeks)(7 days/week)(5 oz/day) = 350 total oz./pot

   $$\frac{350\ \text{oz/pot}}{128\ \text{oz/gal}} = 2.7\ \text{gal fertilizer solution/pot}$$

   $$\frac{\$.69}{100\ \text{gal}} = \frac{X\$}{2.7\ \text{gal}}$$

   $.02/pot = X

   Osmocote lasts 3-4 months so it will only be used once.

   (3 grams/pot)($.0019/gram) = $.001/pot

   Comparing the two types of fertilizers, it would cost less than 1 cent per pot to fertilize the geraniums with Osmocote and 2 cents per pot using Peters.

- Calculating the actual nutrient cost can save a significant amount of money. However, ease of use, reliability and other factors must be considered when making a decision on what fertilizer to use.

OBJECTIVE 15 **Discuss maintaining a fertilizer inventory.**

- Inventories should indicate the exact number of various fertilizers present at anytime. Employees should record when, and what type of fertilizer they removed from the inventory. An annual inventory sheet is shown below.

1989	Bags of fertilizer on hand				
Month	$CaNO_3$	KNO_3	Peters 20-10-20 PL	Osmocote 19-6-12	NH_4NO_3
July	25	50	100	30	50
August	23	46	95	20	44
September	22	42	90	19	38
October	21	36	80	19	34
November	20	30	70	19	27
December	19	25	65	17	21
January	18	22	63	16	17
February	17	17	60	(-1) 19*	15
March	15	15	50	19	14
April	10	12	40	19	8
May	8	9	27	10	3
June	5	5	18	10	2
Total use for year	20	45	82	40	48

*20 additional bags were purchased

The annual fertilizer inventory sheet should be part of the permanent office records. It tells the grower how much fertilizer is being used yearly and when the major periods of use are.

A monthly sign out sheet should be posted in the fertilizer storage area.

Fertilizer Use for the Month of:___________________

		Number bags removed				
Employee	Date	$CaNO_3$	KNO_3	Peters 20-10-20	Osmocote 19-6-12	NH_4NO_3

- Accurate inventory records will help prevent excessive buying or insufficient supply.

OBJECTIVE 16

List the conditions for properly storing fertilizer.

- Proper storage of fertilizers will ensure the safety of greenhouse employees and customers.
- Fertilizers should be kept in a storage area that is locked at all times. The storage area must have a sign warning persons that chemicals are being stored in the area. This area should be protected from exposure to outdoor elements.
- Fertilizer should be stacked on pallets or other shelving material to keep it off the floor and prevent it from becoming wet. Soluble fertilizers like Peters are difficult to dissolve if the bags get wet. Ammonium nitrate has the potential of exploding if it becomes wet.

- Separate the various types of fertilizers into individual stacks and have each stack clearly labeled. This prevents employees from accidentally grabbing the wrong type of fertilizer.

- Newly purchased fertilizers should be placed on the bottom of the correct stack. Older fertilizer should always be on the top of the stack so it will be used first.

- Material safety data sheets (MSDS) must be available for every type of fertilizer kept at the greenhouse. These sheets are obtained from the chemical companies when the fertilizer is purchased.

GUARANTEED ANALYSIS OF 20-10-20 PEAT-LITE SPECIAL

20-10-20
PEAT-LITE SPECIAL

Guaranteed Analysis **565-1038**

For Continuous Liquid Feed Programs

Total Nitrogen (N)	20%
8.0% Ammoniacal Nitrogen	
12.0% Nitrate Nitrogen	
Available Phosphoric Acid (P_2O_5)	10%
Soluble Potash (K_2O)	20%
Total Magnesium (Mg)	0.15%
.15% Water Soluble Magnesium	
Boron (B)	0.02%
Copper (Cu)	0.01%
0.01% Chelated Copper	
Iron (Fe)	0.1%
0.1% Chelated Iron	
Manganese (mn)	0.056%
.056% Chelated Manganese	
Molybdenum (Mo)	0.01%
Zinc (Zn)	0.0162%
.0162% Chelated Zinc	

Derived from:	Ammonium Nitrate, Ammonium Phosphate, Potassium Nitrate, Magnesium Sulfate, Boric Acid, Copper EDTA, Iron DTPA, Manganese EDTA, Sodium Molybdate, Zinc EDTA.
Potential Acidity:	422 Lbs. Calcium Carbonate Equivalent Per Ton.
WARNING:	Contains more than .001% Molybdenum. It should not be used on forage grass for livestock.

25 Lbs. Net Wt. (11.34 kg)

Used with permission of Grace Sierra.

Use Suggestions

Crop Type	Suggested Concentration in ppm Nitrogen Continuous Feeding (Constant Liquid Feeding)	Suggested Concentration in ppm Nitrogen Periodic Feeding (Pulse Feeding)
Bedding Plants	100 - 150	200 - 250
Containerized Woody Plants	75 - 100	300 - 350
Cut Flowers	175 - 225	300 - 450
Pot Chrysanthemums	250 - 300	350 - 400
Potted Easter Lilies	250 - 300	350 - 400
Potted Tropical Foliage	150 - 200	250 - 300
Potted Geraniums	250 - 300	350 - 400
Potted Poinsettias	275 - 300	375 - 400
Plugs (All Types)	75 - 125	175 - 225
Field Crops		
Fruit		25 - 250*
Vegetables		25 - 300*

* The optimum concentration is variable and dependent upon rate (volume applied/area), crop type, stage in cropping period, soil type, rainfall and time of year.

Landscape & Turf Use: Add 3 1/3 pounds in 100 gallons of water and apply to 1000 sq. ft. every four weeks.

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CHECKING INJECTORS WITH A CONDUCTIVITY METER

NOTES
1) For use with meters reading in millimhos with Peters* Fertilizer formulations.
2) The values presented were developed with distilled water solutions of the appropriate Peters* Fertilizers.
3) Test your plain irrigation water first and subtract that reading from the fertilizer-injected water.

Conductivity Readings for Peters* Mixed Soluble Fertilizers

ppm Nitrogen	12-0-43 10-30-20	12-36-14	15-5-25	5-50-17	15-45-5	20-30-10	25-0-25	25-5-15	20-20-20 20-19-18	15-15-15 20-10-20	24-8-16 20-5-30	25-15-15 25-9-17 25-5-20
50	48	53	39	83	43	18	15	24	20	33	22	13
75	71	79	59	1.25	64	26	23	38	30	49	34	20
100	95	1.05	78	1.66	85	35	30	48	40	65	45	27
125	1.19	1.31	98	2.07	1.06	44	38	60	50	81	56	34
150	1.43	1.58	1.17	2.49	1.28	53	45	72	60	98	67	40
175	1.66	1.84	1.37	2.91	1.49	61	53	84	70	1.14	79	47
200	1.90	2.10	1.56	3.32	1.70	70	60	96	80	1.30	90	54
225	2.14	2.36	1.76	3.74	1.91	79	68	1.09	90	1.46	1.01	61
250	2.38	2.63	1.95	4.15	2.13	88	75	1.20	1.00	1.63	1.12	67
275	2.61	2.89	2.15	4.57	2.34	96	83	1.32	1.10	1.79	1.24	74
300	2.85	3.15	2.34	4.98	2.55	1.05	90	1.44	1.20	1.95	1.35	81
350	3.33	3.68	2.73	5.81	2.98	1.23	1.05	1.68	1.40	2.28	1.57	94
400	3.80	4.20	3.12	6.64	3.40	1.40	1.20	1.92	1.60	2.60	1.80	1.08
450	4.28	4.73	3.51	7.47	3.83	1.58	1.35	2.16	1.80	2.93	2.02	1.21
500	4.75	5.25	3.90	8.30	4.25	1.75	1.50	2.40	2.00	3.25	2.25	1.35
550	5.23	5.78	4.29	9.13	4.68	1.93	1.65	2.64	2.20	3.58	2.47	1.48
600	5.70	6.30	4.68	9.96	5.10	2.10	1.80	2.88	2.40	3.90	2.70	1.62
650	6.18	6.63	5.07	10.79	5.53	2.28	1.95	3.12	2.60	4.23	2.92	1.75
700	6.65	7.35	5.46	11.62	5.95	2.45	2.10	3.36	2.80	4.55	3.15	1.89
750	7.13	7.88	5.85	12.45	6.38	2.63	2.25	3.60	3.00	4.88	3.37	2.02
800	7.60	8.40	6.24	13.28	6.80	2.80	2.40	3.84	3.20	5.20	3.60	2.16
850	8.08	8.93	6.63	14.11	7.23	2.98	2.55	4.08	3.40	5.53	3.82	2.29
900	8.55	9.45	7.02	14.94	7.65	3.15	2.70	4.32	3.60	5.85	4.05	2.43
950	9.03	9.98	7.41	15.77	8.08	3.33	2.85	4.56	3.80	6.18	4.27	2.56
1000	9.50	10.50	7.80	16.60	8.50	3.50	3.00	4.80	4.00	6.50	4.50	2.70

Chart continued on next page.

ppm Nitrogen	20-0-20	5-11-26 Hydrosol	16-4-12 15-16-17 15-11-29 15-20-25	4-25-35	20-1-20 15-10-30	20-2-20 20-7-19 15-30-15	15-17-17 15-0-15	21-7-7 Acid	21-7-7 Neutral	28-5-18 27-15-12	25-10-10 30-10-10	7-40-17 9-45-15
50	25	98	34	32	35	31	37	28	21	11	07	60
75	38	1.46	52	49	52	47	56	42	32	16	10	90
100	50	1.95	69	65	70	62	75	56	42	21	14	1.20
125	63	2.44	86	81	87	78	94	70	53	26	17	1.50
150	75	2.93	1.03	97	1.05	93	1.12	84	63	32	21	1.80
175	88	3.31	1.21	1.14	1.22	1.09	1.31	98	74	37	24	2.10
200	1.00	3.90	1.38	1.30	1.40	1.24	1.50	1.12	84	42	28	2.40
225	1.13	4.39	1.55	1.46	1.57	1.40	1.69	1.26	95	47	31	2.70
250	1.25	4.88	1.72	1.62	1.75	1.55	1.87	1.40	1.05	53	35	3.00
275	1.38	5.36	1.90	1.79	1.92	1.71	2.06	1.54	1.16	58	38	3.30
300	1.50	5.85	2.07	1.95	2.10	1.86	2.25	1.68	1.26	63	42	3.60
350	1.75	6.83	2.41	2.27	2.45	2.17	2.62	1.96	1.47	74	49	4.20
400	2.00	7.80	2.76	2.60	2.80	2.48	3.00	2.24	1.68	84	56	4.80
450	2.25	8.78	3.10	2.92	3.15	2.79	3.37	2.52*	1.89	95	63	5.40
500	2.50	9.75	3.45	3.25	3.50	3.10	3.75	2.80	2.10	1.05	70	6.00
550	2.75		3.79	3.57	3.85	3.41	4.12	3.08	2.31	1.16	77	6.60
600	3.00		4.14	3.90	4.20	3.72	4.50	3.36	2.52	1.26	84	7.20
650	3.25		4.48	4.22	4.55	4.03	4.87	3.64	2.73	1.37	91	7.80
700	3.50		4.83	4.55	4.90	4.34	5.25	3.92	2.94	1.47	98	8.40
750	3.75		5.17	4.87	5.25	4.65	5.62	4.20	3.15	1.58	1.05	9.00
800	4.00		5.52	5.20	5.60	4.96	6.00	4.48	3.36	1.68	1.12	9.60
850	4.25		5.86	5.52	5.95	5.27	6.37	4.76	3.57	1.79	1.19	10.20
900	4.50		6.21	5.85	6.30	5.58	6.75	5.04	3.78	1.89	1.26	10.80
950	4.75		6.55	6.17	6.65	5.89	7.12	5.32	3.99	2.00	1.33	11.40
1000	5.00		6.90	6.50	7.00	6.20	7.50	5.60	4.20	2.10	1.40	12.00

Although we believe these results to be accurate based upon the procedure used, we suggest, on a practical basis, that they be considered within ±10% to allow for differences in procedure, weighing, or sampling error.

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CHECKING INJECTORS WITH A CONDUCTIVITY METER

NOTES
1) For use with meters reading in millimhos and solutions made from single element fertilizer components
2) The values presented were developed with distilled water dilutions of single element fertilizer components
3) Test your plain irrigation water first and subtract that reading from the fertilizer-injected water

Conductivity Readings for Single Element Fertilizer Components

ppm Nitrogen	Ammonium Nitrate NH_4NO_3-34%N	Ammonium Sulfate NH_4SO_4-21%N	Sodium Nitrate $NaNO_3$-16%N	Potassium Nitrate KNO_3-14%N	Calcium Nitrate $CaNO_3$-15.5%N
50	23	45	43	48	37
75	35	68	65	71	55
100	46	90	86	95	74
125	58	1.13	1.08	1.18	92
150	69	1.35	1.29	1.42	1.11
175	81	1.58	1.51	1.66	1.30
200	92	1.80	1.72	1.90	1.48
225	1.04	2.03	1.94	2.14	1.66
250	1.15	2.25	2.15	2.37	1.85
275	1.27	2.48	2.37	2.61	2.04
300	1.38	2.70	2.58	2.85	2.22
350	1.61	3.15	3.01	3.32	2.59
400	1.84	3.60	3.44	3.80	2.96
450	2.07	4.05	3.87	4.27	3.33
500	2.30	4.50	4.30	4.75	3.70
550	2.53	4.95	4.73	5.22	4.07
600	2.76	5.40	5.16	5.70	4.44
650	2.99	5.85	5.59	6.17	4.81
700	3.22	6.30	6.02	6.65	5.18
750	3.45	6.75	6.45	7.12	5.50
800	3.68	7.20	6.88	7.60	5.92
850	3.91	7.65	7.31	8.07	6.29
900	4.14	8.10	7.74	8.55	6.66
950	4.37	8.55	8.17	9.02	7.03
1000	4.60	9.00	8.60	9.50	7.40

ppm Mg	Epsom Salts $MgSO_4$-10%Mg
50	38
75	56
100	75
125	94
150	1.13
175	1.31
200	1.50
225	1.69
250	1.88
275	2.06
300	2.25
350	2.63
400	3.00
450	3.38
500	3.75
550	4.13
600	4.50
650	4.88
700	5.25
750	5.63
800	6.00
850	6.38
900	6.75
950	7.13
1000	7.50

Although we believe these results to be accurate based upon the procedure used, we suggest, on a practical basis, that they be considered within ± 10% to allow for differences in procedure, weighing, or sampling error

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ACTIVITY SHEET 1

MAINTAINING PLANT NUTRITION

V

ANALYZE A GROWING MEDIUM FOR NUTRIENT CONTENT

INTRODUCTION

Your ability to analyze growing medium with a greenhouse soil testing kit will help you diagnosis major nutrient deficiencies or toxicities. This test is very helpful while waiting on tissue and medium analysis reports.

EQUIPMENT AND SUPPLIES

- Simplex soil testing kit
- Air dried medium sample
- Distilled water

PROCEDURE

1. Collect a random medium sample 1-2 days before the test is to be done.
2. Place sample in a paper sack and allow to dry.
3. After the sample is dry break up the clods and mix the sample well.
4. Test the growing medium for N, P_2O_5, and K_2O using the procedures given in the kit's manual. Record the nutrient levels.
5. After all results have been recorded compare your results with other students.
6. Discuss necessary nutrition changes with your class.
7. Put away equipment and supplies.

ASSIGNMENT SHEET 1

MAINTAINING PLANT NUTRITION

V

NAME ______________________________ SCORE ________

OBJECTIVE 17 **Determine the rates of fertilizer needed.**

INTRODUCTION Objective 8 explains how to calculate the correct rates of a fertilizer carrier to supply the desired nutrients at the proper concentrations. The activity on this assignment sheet emphasizes this area.

DIRECTIONS Calculate the fertilizer rates for the crops listed below.

1. Geraniums require 220 ppm N constant liquid fertilization using Peters 20-10-20 peat-lite. A hozon injector is being used and the concentrate tank holds 12 gallons. How much Peters is needed to fill the empty concentrate tank?

2. Mums need 300 ppm N CLF using Peters pot mum special 15-10-30. If a gewa is used, how much Peters must be used per 1 gallon of concentrate?

3. A greenhouse is growing 100 4" violets. Since there are so few plants, and they are susceptible to cold water damage, they will be hand watered with a cup and bucket. A 75 ppm N solution must be made using Peters African violet special 12-36-14, and a new 33 gallon trash can will be the fertilizer reservoir. How much Peters is needed to fill the trash can with fertilizer solution?

4. An experienced grower uses ammonium nitrate (34-0-0) and potassium nitrate (13-0-44) to make their own fertilizer solution. How much of each fertilizer is needed to make 100 gallons of a 200 ppm N and 250 ppm K_2O fertilizer solution?

ASSIGNMENT SHEET 2

MAINTAINING PLANT NUTRITION

V

NAME ______________________________ SCORE ________

OBJECTIVE 18 **Decide which fertilizers are the best buy.**

INTRODUCTION Objective 14 explains how to determine the cost of nutrients in different fertilizer carriers. The activity on this assignment sheet emphasizes this area.

DIRECTIONS Determine which fertilizer is cheaper based on the cost of nitrogen.

1. Your greenhouse is currently using Peters pot mum special 15-10-30 at 300 ppm N; this material cost $22.75 for a 25 pound bag. You are thinking about switching to Peters 20-10-20 peat-lite; it cost $20.70 for a 25 pound bag. What is the cost per 100 gallons of a 300 ppm N solution for each fertilizer and which fertilizer would you recommend purchasing?

2. Which is a cheaper way to apply 200 ppm N and 200 ppm K_2O; using Peters 20-10-20 or mixing KNO_3 and $CaNO_3$?

Peters 20-10-20 PL	25 lb bag	$20.70
KNO_3 13-0-44	50 lb bag	$14.50
$CaNO_3$ 15.5-0-0	50 lb bag	$13.95

3. A grower is trying to decide if a slow release or liquid feed program would be cheaper for his mum production. Osmocote 19-6-12 cost $44.35 for a 50 pound bag and Peters pot mum special 15-10-30 cost $22.75 for a 25 pound bag. Each 6" pot would be topdressed with 9 grams of osmocote, or receive 6 ounces of Peters 300 ppm N solution. The crop will be on the bench for 12 weeks. How much will it cost to produce the crop using each fertilizer and what is your recommendation to the grower?

NOTE: 128 oz = 1 gallon 454 grams = 1 pound

ASSIGNMENT ANSWERS

MAINTAINING PLANT NUTRITION

V

ASSIGNMENT SHEET 1

Use the following criteria for evaluation.

- The student should show calculations, that they understand the principle of the formula and how to use it for any fertilizer injector.

1. Hozon ratio is 1:16

$$\frac{(1.33)(200\ \text{ppm})}{20} = 14.63\ \text{oz}/100\ \text{gal}$$

$$\frac{14.63\ \text{oz}}{100\ \text{gal}} = \frac{X\ \text{oz}}{16\ \text{gal}}$$

$$2.34\ \text{oz} = X$$

$$(2.34\ \text{oz}/1\ \text{gal conc.})(12\ \text{gal conc. tank}) = 28.08\ \text{oz}/\ 12\ \text{gal of concentrate}$$

2. Gewa ratio is 1:100

$$\frac{(1.33)(300)}{15} = 26.6\ \text{oz}/100\ \text{gal}$$

26.6 oz/1 gal of concentrate

3. 33 gallon fertilizer solution tank

$$\frac{(1.33)(75)}{12} = 8.3\ \text{oz}/100\ \text{gal}$$

$$\frac{8.3\ \text{oz}}{100\ \text{gal}} = \frac{X\ \text{oz}}{33\ \text{gal}}$$

$$X = 2.7\ \text{oz}/33\ \text{gal solution}$$

4. First find the potassium and then see how much nitrogen is supplied by the potassium nitrate. Next determine how much remaining nitrogen is needed from ammonium nitrate.

$$KNO_3 \quad \frac{(1.33)(250\ \text{ppm})}{44} = 7.6\ \text{oz}\ KNO_3/100\ \text{gal}$$

$$\frac{(1.33)(X\ \text{ppm N})}{13} = 7.6\ \text{oz}/100\ \text{gal}$$

$X = 74.3$ ppm N

KNO_3 supplies 250 ppm K and 74.3 ppm N

$$NH_4NO_3 \quad \frac{(1.33)(125.7\ \text{ppm N})}{34} = 4.9\ \text{oz}/100\ \text{gal}$$

Combine 4.9 oz of NH_4NO_3 and 7.6 oz of KNO_3 per 100 gallons.

ASSIGNMENT SHEET 2

1. Peters 15-10-30 cost $22.75/25 lb bag

$$\frac{\$22.75}{25\ \text{lb}} = \frac{\$0.91/\text{lb}}{16\ \text{oz/lb}} = \$0.057/\text{oz}$$

$$\frac{(1.33)(300\ \text{ppm N})}{15} = 26.6\ \text{oz}/100\ \text{gal}$$

(26.6 oz)($0.057/oz) = $1.52/100 gal

Peters 20-10-20 PL cost $20.70/25 lb bag

$$\frac{\$20.70}{25\ \text{lb}} = \frac{\$0.828/\text{lb}}{16\ \text{oz/lb}} = \$0.052/\text{oz}$$

$$\frac{(1.33)(300\ \text{ppm N})}{20} = 19.95\ \text{oz}/100\ \text{gal}$$

(19.95 oz)($0.052/oz) = $1.04/100 gal

Recommend the Peters 20-10-20PL because it is cheaper to use; $1.04 compared to $1.52.

2. Peters 20-10-20 $\frac{\$20.70}{25\ \text{lb}} = \$0.828/\text{lb} = \$0.052/\text{oz}$

$$\frac{(1.33)(200\ \text{ppm N})}{20} = 13.3\ \text{oz}/100\ \text{gal}$$

(13.3 oz)($0.052/oz) = $0.69/100 gal

$$KNO_3 \quad \frac{\$14.50}{50\ \text{lb}} = \$0.29/\text{lb} = \$0.018/\text{oz}$$

$$\frac{(1.33)(200 \text{ ppm K})}{44} = 6.05 \text{ oz/100 gal}$$

$$(6.05 \text{ oz})(\$0.018/\text{oz}) = \$0.11/100 \text{ gal}$$

How much N is in the 6.05 oz KNO_3?

$$\frac{(1.33)(X \text{ ppm N})}{13} = 6.05 \text{ oz/100 gal}$$

$$X = 59.1 \text{ ppm N}$$

$$CaNO_3 \quad \frac{\$13.95}{50 \text{ lb}} = \$0.279/\text{lb} = \$0.017/\text{oz}$$

$$\frac{(1.33)(140.9 \text{ ppm N})}{15.5} = 12.1 \text{ oz/100 gal}$$

$$(12.1 \text{ oz})(\$0.017/\text{oz}) = \$0.21/100 \text{ gal}$$

To make a 200 ppm N and K_2O solution Peters cost \$0.69/100 gal; KNO_3 and $CaNO_3$ cost \$0.32/100 gal. Mixing your own fertilizer is cheaper.

3. Osmocote 19-6-12 will be applied one time and Peters will be applied 84 times (12 weeks X 7 days/week). Each pot will receive a total of 504 oz (6 oz X 84 applications).

$$\text{Peters 15-10-30} \quad \frac{\$22.75}{25 \text{ lb}} = \$0.91/\text{lb} = \$0.057/\text{oz}$$

$$\frac{(1.33)(300 \text{ ppm N})}{15} = \$26.6 \text{ oz/100 gal} = .266 \text{ oz/gal}$$

$$\frac{(.266 \text{ oz/gal})(504 \text{ oz})}{128 \text{ oz/gal}} (\$0.057/\text{oz}) = \$0.06/\text{pot}$$

$$\text{Osmocote 19-6-12} \quad \frac{\$44.35}{50 \text{ lb}} = \$0.887/\text{lb} = \$0.002/\text{gm}$$

$$(\$0.002/\text{gm})(9 \text{ gm/pot}) = \$0.018/\text{pot}$$

It will cost 6 cents/pot using Peters 15-10-30 and 1.8 cents/pot using Osmocote 19-6-12. Recommend using Osmocote since it is cheaper and only has to be applied one time.

MAINTAINING PLANT NUTRITION

OBJECTIVE 19a

Check the precision of fertilizer injectors.

INTRODUCTION

All greenhouse injectors should periodically be checked to determine if they are precisely mixing the fertilizer. Testing the conductivity of a Peters fertilizer solution will allow the grower to verify the strength of the fertilizer solution being mixed.

EQUIPMENT AND SUPPLIES

- Conductivity meter
- Glass beakers
- Peters conductivity chart
- Peters fertilizer solution

PROCEDURE

1. Collect a beaker of tap water used to mix the fertilizer solution.
2. Collect a beaker of fertilizer solution coming from the injector.
3. Test and record the conductivity reading for the tap water.
4. Test and record the conductivity of the fertilizer solution.
5. Subtract the tap water reading from the fertilizer solution reading; this number is the conductivity reading of the fertilizer only. Use this number when checking the table.
6. Locate the Peters fertilizer you are using across the top row of the table.Go down that column until you find the number closest to your conductivity reading and stop. Follow that row left until you reach the ppm N column.

   This ppm N determined from the chart is the strength of the fertilizer solution coming from your injector.

   The chart notes a +/- 10% difference in conductivity readings. This method of testing the calibration of an injector helps discover major errors.
7. If your tested ppm is greatly different than the supposed ppm, go back and check all calculations and weighing procedures.
8. If no error is found, inspect the injector and look for the problem; clogged screens, vacuum bubbles, etc.
9. Put away equipment and supplies.

JOB SHEET 2

MAINTAINING PLANT NUTRITION

V

OBJECTIVE 19b

Measure the total soluble salt content of a growing medium.

INTRODUCTION

The total soluble salt content of a growing medium has a large effect on the quality of the plants produced. A total soluble salt test should always be done in conjunction with a nutrient or media analysis. The soluble salt level may provide the answer to nutritional problems.

EQUIPMENT AND SUPPLIES

- Glass beakers
- Distilled water
- Conductivity meter
- Thermometer
- Air dried growing medium sample

PROCEDURE

1. Collect a random medium sample 1-2 days before testing the medium.
2. Place one tablespoon of air dried growing medium in a beaker and add 40cc of distilled water.
3. Stir. Stir three more times in a 30 minute period.
4. Place a thermometer in the solution and record the temperature.
5. If the conductivity meter has to be adjusted for temperature, set the temperature to your solutions temperature.
6. Take the conductivity reading. Check your results with the numbers in the Interpretation of Total Soluble Salts Test Table.
7. Compare your results with those of your classmates. Discuss any problems with your instructor and recommend correction procedures if needed.
8. Put away equipment and supplies.

JOB SHEET 3

MAINTAINING PLANT NUTRITION

OBJECTIVE 19c

Test growing medium pH.

INTRODUCTION

The pH of a growing medium has a tremendous affect on the availability and uptake of plant nutrients in a growing medium.

EQUIPMENT AND SUPPLIES

- Glass beakers
- Distilled water
- pH meter
- Air dried growing medium sample

PROCEDURE

1. Collect a random medium sample 1-2 days before the test is done.
2. Place one tablespoon of the dried growing medium sample in a glass beaker and add 30cc of distilled water.
3. Stir and let stand for 20 minutes. Stir two more times within the 20 minutes.
4. Take the pH reading.

   NOTE: It is common for the pH to drift slightly while taking the reading. This is due to the rapid association and dissociation of the ions in a soilless medium.
5. Compare results with your classmates and discuss any necessary adjustments.
6. Put away equipment and supplies.

PRACTICAL TEST 1

MAINTAINING PLANT NUTRITION

V

JOB SHEET 1

Check the precision of fertilizer injectors.

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Collected a beaker of tap water used to mix the fertilizer solution.	_____	_____
2. Collected a beaker of fertilizer solution coming from the injector.	_____	_____
3. Tested and recorded the conductivity reading for the tap water.	_____	_____
4. Tested and recorded the conductivity of the fertilizer solution.	_____	_____
5. Subtracted the tap water reading from the fertilizer solution reading.	_____	_____
6. Determined the ppm from the Peters chart.	_____	_____
7. If the tested ppm was greatly different than the supposed ppm, went back and checked all calculations and weighing procedures.	_____	_____
8. If no error was found, inspected the injector and looked for the problem; clogged screens, vacuum bubbles, etc.	_____	_____
9. Put away equipment and supplies.	_____	_____

EVALUATOR'S COMMENTS

____

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key). A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Conductivity of fertilizer solution correctly determined	4	3	2	1
Conductivity of tap water subtracted from fertilizer solution reading	4	3	2	1
Correct use of table	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training

3 - Moderately skilled—Has performed job during training program; limited additional training may be required

2 - Limited skill—Has performed job during training program; additional training is required to develop skill

1 - Unskilled—Is familiar with process; but is unable to perform job

PRACTICAL TEST 2

MAINTAINING PLANT NUTRITION

V

JOB SHEET 2

Measure the total soluble salt content of a growing medium.

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Collected a random medium sample 1-2 days before testing the medium.	_____	_____
2. Placed 1 tablespoon of air dried growing medium in a beaker and added 40cc of distilled water.	_____	_____
3. Stirred. Stirred 3 more times in a 30 minute period.	_____	_____
4. Placed a thermometer in the solution and recorded the temperature.	_____	_____
5. If the conductivity meter had to be adjusted for temperature, set the temperature to the solutions temperature.	_____	_____
6. Took the conductivity reading. Checked results with the numbers in Total Soluble Salts Table.	_____	_____
7. Compared results with those of classmates. Discussed any problems with instructor and recommended correction procedures if needed.	_____	_____
8. Put away equipment and supplies.	_____	_____

EVALUATOR'S COMMENTS

____

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key). A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Media sample collected correctly	4	3	2	1
Correct amount of distilled water added	4	3	2	1
Solution stirred properly	4	3	2	1
Conductivity reading correctly taken	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training

3 - Moderately skilled—Has performed job during training program; limited additional training may be required

2 - Limited skill—Has performed job during training program; additional training is required to develop skill

1 - Unskilled—Is familiar with process; but is unable to perform job

PRACTICAL TEST 3

MAINTAINING PLANT NUTRITION

V

JOB SHEET 3

Test growing medium pH.

Student's name ____________________________ Date ____________

Evaluator's name ___________________________ Attempt no. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Collected a random medium sample 1-2 days before test.	______	______
2. Placed 1 tablespoon of the dried growing medium sample in a glass beaker and added 30cc of distilled water.	______	______
3. Stirred and let stand for 20 minutes. Stirred two more times within the 20 minutes.	______	______
4. Took the pH reading.	______	______
5. Compared results with those of classmates and discussed any necessary adjustments.	______	______
6. Put away equipment and supplies.	______	______

EVALUATOR'S COMMENTS

____

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key). A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Sample correctly taken	4	3	2	1
Correct amount of distilled water added	4	3	2	1
pH meter properly calibrated	4	3	2	1
pH reading within normal limits	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training
3 - Moderately skilled—Has performed job during training program; limited additional training may be required
2 - Limited skill—Has performed job during training program; additional training is required to develop skill
1 - Unskilled—Is familiar with process; but is unable to perform job

WRITTEN TEST

MAINTAINING PLANT NUTRITION V

NAME ______________________ SCORE ______

OBJECTIVE 1

List the essential plant nutrients.

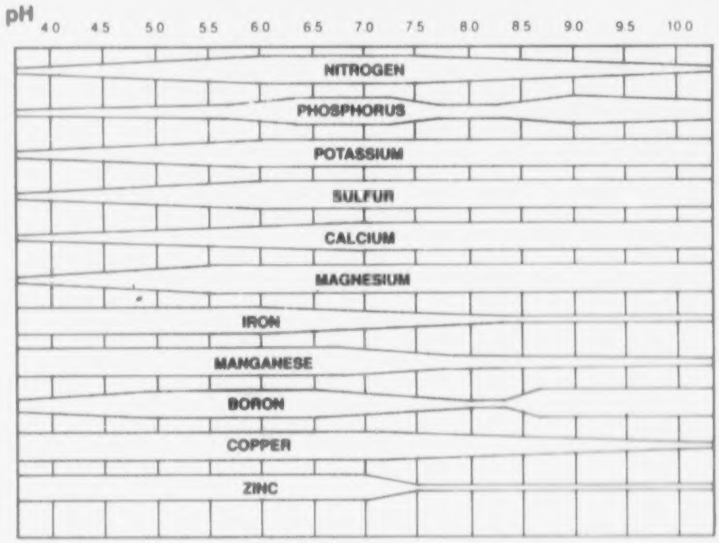
1. List three macronutrients.

2. List four micronutrients.

OBJECTIVE 2

Identify how media pH affects nutrient availability. Place an "I" in the blank if the availability of the element increases, "D" if availability decreases and "N" if the availability is not affected.

Availability Scale



1. The media pH goes from 5.5 to 7.4.

_____ magnesium
_____ iron
_____ nitrogen
_____ potassium
_____ boron

2. The media pH drops from 6.4 to 4.9.

_____ phosphorus
_____ calcium
_____ zinc
_____ magnesium

OBJECTIVE 3

Discuss fertilizer reaction on media pH.

The medium pH of your geranium stock plants is 4.9. The proper pH is 6.0 - 6.2; how are you going to increase it to thte normal range.

OBJECTIVE 4

Discuss the effect of fertilizers on total soluble salt concentrations.

1. What does total soluble salt mean?

2. What does a very low total soluble salt reading indicate?

3. How can you reduce the total soluble salt concentration in a crop of 6" poinsettias?

4. What is a normal total soluble salt reading for a peat lite mix?

OBJECTIVE 5

Describe various fertilizing methods.

1. Define a weekly liquid feed program and a CLF program.

2. Explain the roller coaster effect of the weekly feed program.

OBJECTIVE 6

Select from a list true statements about choosing and maintaining fertilizing equipment. Write an "X" in the blank before each true statement.

____ 1. Applying liquid fertilizer by hand is feasible only on a small sized specialty crops.

____ 2. Injectors for liquid fertility programs cannot be purchased for less than $500.

____ 3. Liquid fertilizer cannot be put through automatic watering systems because the salt ruins the emitter.

____ 4. All fertilizer injectors require a concentrate tank.

__ 5. Hozons have a proportioning ratio of 1:16 and are generally used by small sized greenhouses.

____ 6. Commander proportioners have a ratio of 1:128 and the hydraulic pump is run by electricity.

____ 7. Gewa is good for moving to multiple locations.

____ 8. The major drawback of a Smith injector is that it has to be sent back to the factory for repairs.

OBJECTIVE 7

Discuss fertilizers and nutrient rates.

1. What are the three major types of fertilizers a grower could use?

2. Why is Peters fertilizer so popular in greenhouse fertility programs?

____

____

____

____

____

3. Would you recommend that a new greenhouse grower mix their own fertilizer, and why?

____

____

____

____

4. What are the two forms of nitrogen present in fertilizers, and what form does the plant prefer?

____

____

____

____

5. What form of nitrogen is available in the largest percent in peat-lite fertilizers, and why?

____

____

____

____

6. What crops are considered moderate fertilizer users and what is the recommended CLF rate for these crops?

____

____

____

____

OBJECTIVE 8

Calculate fertilizer rates.

1. How much Peters 20-10-20 PL fertilizer is needed per gallon of concentrate to make a 225 ppm N solution? Your injector is a Gewa with a 1:100 ratio.

2. How much ammonium nitrate 34-0-0 is needed per gallon of concentrate to produce 75 ppm N using a hozon?

3. How much potassium nitrate 13-0-44 and ammonium nitrate 34-0-0 is needed to make a 250 ppm N and K2O solution?

OBJECTIVE 9

Discuss monitoring fertilizing equipment and repairing if required.

1. What does it mean when the water is coming from the bottom drain valve of the Gewa is blue?

2. How can brass injector parts be cleaned?

3. Why is it important to keep the screen on the suction hose of an injector clean?

OBJECTIVE 10

Discuss media tests for nutrient levels.

1. Do media analysis results indicate the nutrient content within a plant?

2. What two other media tests should always be done in conjunction with a media nutrient analysis?

3. What is the major difference between a medium test done by the greenhouse grower and one done by a professional lab?

4. How often should a grower have the medium analyzed for a crop?

5. Explain how to collect a media sample from a crop of 6" mums that are topdressed with Osmocote and send it to the lab.

OBJECTIVE 11 **Discuss collecting tissue samples for nutritional monitoring.**

1. What is the most common plant tissue sample used for nutrient analysis?

2 A tissue analysis report says that potassium is deficient in the plants, but the media analysis says the potassium is in the normal range. What is the problem?

3. What type of container should a tissue sample be placed in to mail to the lab?

OBJECTIVE 12

Select from a list true statements about nutritional deficiency and toxicity problems. Write an "X" in the blank before each true statement.

____ 1. Distortion or damage of plant foliage can only be caused by insects or disease.

____ 2. Each nutrient deficiency will display a characteristic symptom that helps identify the cause.

____ 3. Mobile elements will show deficiency symptoms in the older foliage first.

____ 4. Immobile elements will show deficiency symptoms in older foliage first.

____ 5. Mobile elements are capable of being transported within the plant but immobile elements are not.

____ 6. Nutrient toxicities can easily be diagnosed visually.

____ 7. Purpling of older foliage indicates a potassium deficiency.

_____ 8. Death of the growing point indicates a calcium deficiency.

_____ 9. Nitrogen deficiency is characterized by the older leaves turning yellow and then falling off.

____ 10. Iron deficiency causes young leaves to have interveinal chlorosis.

____ 11. Nutrient toxicities are often displayed as a deficiency of another element.

____ 12. Tissue analysis must be done to diagnosis a nutrient toxicity.

____ 13. Poor quality fertilizer carriers are often contaminated with high levels of micronutrients.

____ 14. The pH of a growing medium has no affect on nutrient availability.

____ 15. Testing the irrigation water for nutrient content could reveal the source of excess trace elements.

OBJECTIVE 13

Discuss correcting nutritional deficiencies.

Why do you have to be very careful when trying to correct a micronutrient deficiency?

OBJECTIVE 14

Calculate fertilizer cost and maintain a fertilizer inventory.

1. A greenhouse grower is trying to decide if Peters 20-10-20PL or Peters 15-16-17 would be cheaper to use. Both materials come in a 25 pound bag and 20-10-20 cost $20.70 and 15-16-17 cost $18.45. Calculate the cost per 100 gallons for a 300 ppm N solution.

OBJECTIVE 15

Discuss maintaining a fertilizer inventory.

Why is keeping annual fertilizer inventory records important when purchasing fertilizers for the greenhouse?

OBJECTIVE 16

List the conditions for properly storing fertilizer.

List the conditions necessary for an area to properly store fertilizers.

NOTICE The following assignment sheets and job sheets are not part of the written test. If these activities have not been completed check with the instructor.

OBJECTIVE 17 **Determine the rates of fertilizer needed.** SCORE ________

OBJECTIVE 18 **Decide which fertilizers are the best buy.** SCORE ________

OBJECTIVE 19 **Demonstrate the ability to**

a. **Check the precision of fertilizer injectors.** RATING _______

b. **Measure the total soluble salt content of a growing medium.** RATING _______

c. **Test growing medium pH.** RATING _______

WRITTEN TEST ANSWERS

MAINTAINING PLANT NUTRITION

V

OBJECTIVE 1

1. Answer should include any three of the following:
   - N
   - P
   - K
   - Ca
   - Mg
   - S
2. Answer should include any four of the following:
   - Fe
   - Mn
   - Zn
   - Cu
   - B
   - Mo
   - Na
   - Cl

OBJECTIVE 2

1. N, D, I, I, D
2. D, D, N, D

OBJECTIVE 3

Apply a solution of hydrated lime, 1 pound of hydrated lime in 5 gallons of water; drench the media.

OBJECTIVE 4

1. The total ions dissolved in the media solution; Ca,K, NO_3, Na, Mg etc.
2. Low fertility or nutrition
3. Answer should include the following:
   - Leach the media with plain water
   - Feed with moderate rates of fertilizers
   - Thoroughly water a container; water drips out of the container
4. 1.0 - 1.5 millimhos/cm

OBJECTIVE 5

1. A weekly fertility program applies high rates of nutrients once a week and clear water the rest of the time. A CLF program applies moderate rates of nutrients at every watering.
2. With a weekly fertilizer program the plants receive excessive amounts of nutrients at fertilizing time and are starving by the end of the week.

OBJECTIVE 6

1, 4, 5, 7, 8

OBJECTIVE 7

1. Slow release, water soluble complete, mix your own dry carriers
2. Easy to use and it contains all nutrients
3. No, can have trouble supplying all the micronutrients required by the plant
4. Nitrate and ammonium nitrogen; plants prefer the nitrate form
5. Nitrate nitrogen; to prevent ammonium toxicity problems in a soilless medium
6. Bedding and pot plants, roses, geraniums. Use a rate of 200-250 ppm N CLF

OBJECTIVE 8

1. $\frac{(1.33)(225)}{20} = 14.96$ oz/100 gal

   14.96 oz/1 gal of concentrate

2. $\frac{(1.33)(75)}{34} = 2.93$ oz/100 gal

   $\frac{2.93 \text{ oz}}{100 \text{ gal}} = \frac{X \text{ oz}}{16 \text{ gal}}$

   X = .468 oz/1 gal concentrate

3. $\frac{(1.33)(250 \text{ ppm K})}{44} = 7.6$ oz/100 gal

   $\frac{(1.33)(X \text{ ppm N})}{13} = 7.6$ oz/100 gal

   X = 74.3 ppm N

   $\frac{(1.33)(175.7 \text{ ppm N})}{34} = 6.9$ oz/100 gal

   Mix together 7.6 oz KNO_3 and
   6.9 oz NH_4NO_3 per 100 gal

OBJECTIVE 9

1. The membrane has a hole in it and the fertilizer concentrate is leaking out; the membrane should be replaced.
2. Soak in food grade phosphoric acid.
3. So the injector can draw in the correct amount of fertilizer concentrate. If the screen is clogged the machine will not properly mix the fertilizer solution.

OBJECTIVE 10

1. No, plants do not immediately absorb the nutrients that are in the medium. The nutrients may be unavailable to the plant.
2. pH and soluble salt concentration.
3. Greenhouse tests give ballpark ranges for the major nutrients; laboratory tests give results that are very accurate and they can test for macronutrients and micronutrients.
4. At least three times during production.
5. Choose at least eight random pots.

   Scrape away the Osmocote and the top 1" of medium.

   Collect a core sample from each pot.

   Mix the samples together to form one large sample.

   Put sample in a plastic bag or soil sample mailer.

   Fill out information sheet completely.

   Mail sample to lab.

OBJECTIVE 11

1. Topmost two recently matured leaves
2. Another element (N) is available in excessive amounts and is inhibiting the plant from taking up the K
3. Paper sack or tissue analysis sample mailer

OBJECTIVE 12

2, 3, 5, 8, 9, 10, 11, 12, 13, 15

OBJECTIVE 13

These elements are required in very small amounts and it is easy to apply too much, and then a toxicity will result. Toxicities are more difficult to control than a deficiency because the excess nutrient cannot be easily leached from the medium

OBJECTIVE 14

1. Peters 20-10-20 cost \$20.70 per bag

$$\frac{\$20.70}{25\text{ lb}} = \$0.828/\text{lb} = \$0.052/\text{oz}$$

$$\frac{(1.33)(300\text{ ppm N})}{20} = 19.95\text{ oz}/100\text{ gal}$$

$$(19.95\text{ oz})(\$0.052/\text{oz}) = \$1.04/100\text{ gal}$$

Peters 15-16-17 cost \$18.45 per bag

$$\frac{\$18.45}{25\text{ lb}} = \$0.738/\text{lb} = \$0.046/\text{oz}$$

$$\frac{(1.33)(300\text{ ppm N})}{15} = 26.6\text{ oz}/100\text{ gal}$$

$$(26.6\text{ oz})(\$0.046/\text{oz}) = \$1.22/100\text{ gal}$$

Peters 20-10-20 would be cheaper to use

OBJECTIVE 15

It lets the grower know exactly how much fertilizer is being used each month. It prevents excessive or insufficient buying.

OBJECTIVE 16

Answer should include the following key points:

- Must be able to lock the area
- Protected from wind and rain
- Be posted with a sign saying chemical storage
- Have shelves to keep fertilizers off the floor
- Prevent the fertilizers from getting wet

OBJECTIVE 17

Refer to answers to Assignment Sheet 1.

OBJECTIVE 18

Refer to answers to Assignment Sheet 2.

OBJECTIVE 19

Refer to Practical Test for Job Sheets 1 through 3.

OBJECTIVE SHEET

PRODUCING A CROP

VI

INTRODUCTION

There are many decisions and cultural procedures that must be done when producing a crop. The grower must be able to keep track of the crop inventory during production, complete cultural practices in a timely manner, and prepare the plants for the retail market. To be able to successfully sell a crop on a specified date, the grower must calculate the entire production schedule beforehand and then accurately follow that schedule.

UNIT OBJECTIVE

After completing this unit, the student should be able to schedule and correctly produce any greenhouse crop. The student will demonstrate these competencies by completing the assignment sheets, job sheets and written test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with greenhouse crop production to their correct definitions.
2. Discuss selecting production containers.
3. Calculate space requirements for crop production.
4. Select from a list true statements about developing production records and maintaining a product inventory.
5. Discuss pinching and disbudding plants.
6. Select from a list true statements about planning production schedules.
7. Discuss proper acclimatization procedures.
8. Determine the space needed to grow a crop. (Assignment Sheet 1)
9. Calculate a production schedule for a crop. (Assignment Sheet 2)
10. Demonstrate the ability to
    a. Produce a foliage hanging basket. (Job Sheet 1)
    b. Produce a crop of pot mums. (Job Sheet 2)

SUGGESTED ACTIVITIES

PRODUCING A CROP VI

PREPARATION

- Obtain materials to supplement unit.

  NOTE: See Suggested Resources.

- Review instructional outline for this unit. Modify time frames to suit class needs and plan activities for each class period.
- Study the specific objectives to determine those you will cover in your presentation. Decide also which objectives should be taught to which students.
- Determine scope and sequence of objectives that you add. Design and develop support materials, including evaluation techniques, for additional objectives.
- Determine how you will schedule time for students to demonstrate competence in the required procedures.
- Make arrangements for guest speakers. Supply speakers with specific objectives and other appropriate sections of the unit.
- Set up a long or short day bench, whichever will be needed.
- Make sure there will be enough vine type foliage stock plants for student cuttings.
- Assemble a collection of growing containers; cell packs, peat pot, jiffy pellet, standard pot, etc.
- Devise a production record sheet that the students can fill out as they produce a crop.

DELIVERY

Objectives 1 through 3

- Introduce the topic of producing a crop. Stress the importance of knowing how to properly produce a crop.
- Discuss terms associated with greenhouse crop production.
- Discuss different production containers. Bring different production containers to class and discuss the advantages and disadvantages of each.
- Discuss space requirements for crop production.

Objectives 4 and 5

- Discuss production records and maintaining a product inventory.
- Show students how to fill out crop production records.
- Discuss how to pinch and disbud plants.
- Demonstrate how to pinch and disbud a plant.
- Give students the opportunity to practice pinching and disbudding plants.

Objective 6

- Discuss production schedules.
- Have students develop a production schedule for the mums they will grow in class.

Objective 7

- Discuss proper acclimatization procedures.
- Have students develop a plan to acclimate their mums.

APPLICATION

Objective 8

- Use Assignment Sheet 1 to teach students how to determine the space needed to grow a crop.

Objective 9

- Use Assignment Sheet 2 to teach students how to calculate a production schedule for a crop.

Objective 10

- Use Job Sheet 1 to have students produce a foliage hanging basket.
- Use Job Sheet 2 to have students produce a crop of pot mums.

EVALUATION

Practical Test

- Explain to students that they will be asked to deomonstrate procedures on the job sheets to complete the practical test.
- Describe the rating scale used on the practical test.
- Give practical test.
- Reteach and retest as necessary.

Written Test

- Explain to students that they will be asked to demonstrate on the written test actions listed in the specific objectives.
- Give written test.

  NOTE: Written test may be given in sections if desired.
- Evaluate students on assignment sheet activities if not previously done.
- Reteach and retest if necessary.
- Complete appropriate section of competency profiles.
- Review individual and group performance in order to evaluate teaching methods. Adjust scope, sequence, or instructional approaches for additional lessons as required.

SUGGESTED RESOURCES

Publications

- Ball, Vic, *Ball Redbook*, 14th ed., Reston Publishing Company Inc., Reston, Virginia 1985.
- DeHertogh, A.A, *Holland Bulb Forcer's Guide*, 3rd ed., The International Flower-Bulb Centre, Hillegom, The Netherlands, 1985.
- Ecke, Paul, Jr., *Ecke's Poinsettia Manual*, Paul Ecke Poinsettias, Encinitas, California, 1976.

Other Media

- Order B-Nine, 8" hanging baskets and 6" azalea pots if not in stock.
- Order rooted mum cuttings of a medium type that can be produced using center bud or regular disbudding.

UNIT REFERENCES

- *A.H. Hummert Seed Company Catalog*, A.H. Hummert Seed Co., St. Louis, Missouri, 1989.
- Ball, Vic, *Ball Redbook*, 14th ed., Reston Publishing Company, Inc., Reston, Virginia, 1985
- DeHertogh, A.A., *Holland Bulb Forcer's Guide*, 3rd ed., The International Flower-Bulb Centre, Hillegom, The Netherlands, 1985.
- Ecke, Paul, Jr., *Ecke's Poinsettia Manual*, Paul Ecke Poinsettias, Encinitas, California, 1976.
- Larson, Roy A., *Introduction to Floriculture*, Academic Press, Inc., New York, New York, 1980.

BASIC ACADEMIC SKILLS

The following table identifies the basic academic skills that are reinforced in this unit of instruction. These basic academic skills were identified using *The Basic/Essential Skills Taxonomy*, 2nd edition, and verified during the validation process.

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 1	Language Arts 013	Applies/Uses	Definitions	
OBJECTIVE 2	Language Arts 132	Comprehends	Information-written	
	Language Arts 038	Collects/ Organizes	Information-oral/written	
	Mathematics 073	Computes	Multiplication	Whole numbers
OBJECTIVE 3	Mathematics 231	Solves Problems	Proportion	Area
OBJECTIVE 4	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity
	Free Enterprise 118	Identifies	Cost factors	
OBJECTIVE 5	Language Arts 013	Applies/Uses	Definitions	
	Science 382	Describes/ Explains	Plants	Parts/ functions

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 6	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity
	Language Arts 013	Applies/Uses	Definitions	
OBJECTIVE 7	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
	Science 388	Describes/ Explains	Plants	Water
OBJECTIVE 8	Mathematics 231	Solves Problems	Proportion	Area
	Mathematics 034	Computes	Addition	Whole numbers
	Mathematics 073	Computes	Multiplication	Whole numbers
	Mathematics 047	Computes	Division	Whole numbers
	Mathematics 261	Uses calculator	Addition	
	Mathematics 262	Uses calculator	Division	
	Mathematics 266	Uses calculator	Multiplication	
OBJECTIVE 9	Mathematics 229	Solves problems	Generate conclusions	Deductive reasoning
	Language Arts 035	Attends	Directions/ task	
	Language Arts 038	Collects/ Organizes	Information-oral/written	

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVES 10a-b	Language Arts 035	Attends	Directions/ task	

INFORMATION SHEET

PRODUCING A CROP

VI

OBJECTIVE 1

Match terms associated with greenhouse crop production to their correct definitions.

- **Azalea pot**—A growing container that is 3/4 as tall as the top diameter
- **Bulb pan**—A shallow growing container that is 1/2 as tall as the diameter
- **Cell pack**—A thin plastic growing container that is divided into individual compartments
- **Disbudding**—A technique that removes immature flower buds from stem terminals to improve the floral display of the remaining buds
- **Hanging basket**—A growing container that has holes around the edge where wires are attached so the container can be hung and plants will cascade over the edges
- **Jiffy pellet**—Compressed peat moss disc enclosed by mesh that expands into a 1.5" growing container when it absorbs water
- **Peat pot**—Small growing container that is made from compressed peat moss and wood fiber
- **Pinching**—Removing the apical growing point of a shoot, forcing it to branch
- **Standard pot**—A growing container that is as tall as the top diameter
- **Square feet weeks**—A number that identifies how long a plant has been on the production bench and the square footage it occupied during that time
- **Vernalization**—A treatment that exposes a plant or bulb to cold temperatures so flowers will develop

OBJECTIVE 2

Discuss selecting production containers.

Today there are numerous kinds and colors of production containers available through horticultural supply companies. It is a grower's choice as to what kind of container will be used. Currently, plastic is by far the most commonly used type of container. Plastic is used for flats, cell packs, pots and hanging baskets. These products are derived from petroleum and their price is determined by that material. In the future growers will look for production containers that are cheaper and easier on the environment. Consider these factors when selecting production containers.

- **The kind of container your market wants**—Most retail stores and garden centers prefer larger sized containers whereas the mass market outlets prefer smaller sized containers. Make sure your market wants, and is willing to pay for, 4" petunias instead of cell pack petunias. Consider using the same size of containers as local competition to create a standard marketing product.

- **Durability of the container**—Will the container hold up for you during production, and for the consumer when they get it home? Often a slightly more expensive container is worth the extra money in the long run.

- **Does the container fit your production systems**—Automated equipment is not very flexible on the type of containers it can use; a pot filling machine may be limited to round pots. Will the cell packs fit accurately in the flats you have?

- **Limit the number of different sized containers**—Purchase only as many different sized containers as absolutely necessary. Fewer different sized containers are easier to store, use and are cheaper to buy in volume.

Below is a brief discussion of the various types of containers and the crops they are commonly used on.

- **Plastic pots**—can be purchased in many sizes and colors; green or black are most common. Some growers are beginning to color coordinate the pot color with the crop cultivar; yellow mums are grown in yellow pots. This allows shipping personnel to accurately and quickly fill orders.

  - Azalea pots are most frequently used. Four and six inch pots are generally used for the production of blooming potted plants; occasionally 8 or 10 inch pots are used to produce "special" plants for retail sales. Recently 4 inch pots have been used to produce bedding plants; sales of 4 inch pots are increasing yearly.

  - Standard pots are used infrequently. Production of potted lilies, Easter and hybrid, use the 6 inch size. These pots require slightly more media than their azalea counterpart.

- **Plastic cell packs**—are most commonly used in bedding plant production. Consumers like the packs because each plant has its own separate root ball and they are easy to plant outdoors. Growers like cell packs because they allow many plants to be grown in a small area.

  - Cell packs are sold according to the number of plants that will be produced in one flat (11" x 22"). 806's will produce 48 plants per flat; 8 cell packs in a flat and each pack contains 6 plants.

    NOTE: A.H. Hummert's catalog has a good description of the various cell packs available. Growers today are using packs that have 48 or fewer plants per flat; consumers want larger plants and are willing to pay for them.

- **Hanging baskets**—are mainly used for annual bedding plants and indoor foliage plants. Ten inch plastic is used for retail and garden center sales; however, mass markets prefer 8 inch plastic.

  - Wire baskets lined with sheet moss have become very popular recently. They are generally at least 10 inch baskets planted with bedding plants and are used as outdoor patio planters.

- **Peat pots**—have historically been used to produce vegetable transplants that do not perform well when removed from a container; squash, watermelon, cantaloupe. They can also be used on perennial plants that do not transplant well.

  - Consumers like these pots because they simply place the plant and pot in the ground.

  - They are rather expensive because they are not produced in mass numbers like plastic pots. Special containers can be purchased to hold 6 or 12 peat pots together in a group.

- **Jiffy pellets**—can be used to produce vegetable transplants. Occasionally these pellets can be used for certain bedding plants, but they are difficult to manage. They quickly lose their ability to stand upright and become a problem to water. Once the root mass has emerged from the pellet they are subject to rapid drying.
  - Several sizes of pellets are available and they come with or without nutrients.

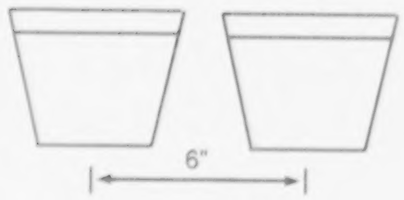
OBJECTIVE 3

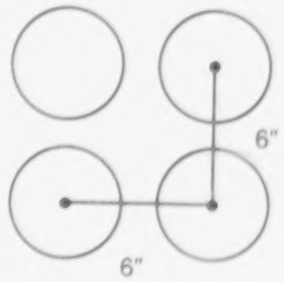
Calculate space requirements for crop production.

Enough space must be available for each phase of producing a crop. To ensure that adequate space will be available, the grower must calculate how much space will be needed for each phase of production, and how long the plant will occupy that space. For example: 100 6" pot mums grown at a 12" x 12" spacing will require 100 square feet of bench space

$$\frac{(12" \times 12")}{144 \text{ sq. in/sq ft}} \text{ (100 pots)} = 100 \text{ square feet}$$

- Proper spacing for crop production can be found in the literature; grow the crop at a 6 x 6 (inch) spacing. The distance between the pots should be measured from center to center.





  - Crops are sometimes grown at several different spacings; grow pot to pot for the first 3 weeks, then move to a 5" x 5" spacing for 3 weeks and finish at a 12" x 12" spacing.
  - Sometimes the spacing will be given as pot to pot; this means to place the pots as close together as possible. A pot to pot spacing uses a spacing equal to the pot size when calculating the square footage; if it is a 6" pot then calculate a 6" x 6" spacing, a 4" pot would use a 4" x 4" spacing when calculating the square footage, flats grown flat to flat should be figured at an 11" x 22" spacing (the size of a flat).

- Once the spacing is known the grower can calculate how much space each container will use. When that is known then the total space needed for the entire crop can be determined.
  - To figure the square feet occupied by a pot, multiply the spacing of the pot and divide by 144 (square inches/square foot). A plant grown at a 6" x 6" spacing occupies .25 square feet; 6" x 6" ÷ 144 = .25 sq ft
- Calculate the square footage needed for the entire crop. Take the square footage for one container and multiply it by the number of containers to be grown. 500 pots grown at a 6" x 6" spacing will require 125 square feet; 500 pots x .25 square feet/pot = 125 sq.ft.
- Determine when the space will be needed and for how long. After the schedule for a crop has been planned, the grower knows exactly when specific bench space will be required and for how long.
- Decide if there is enough space available. Since the grower knows when, and how much space is needed, they can check the benches, and other production plans to see if enough space will be available.
  - To determine how much square footage a bench has, multiply the bench width by its length; a bench 4.5 feet wide and 60 feet long contains 270 square feet of growing space (4.5 x 60 = 270)
  - When all these figures are determined, and the grower has checked the availability of bench space at the time of crop production, they will know if they can grow the crop as planned or if changes need to be made. Maybe there won't be enough space for 500 pots but they could grow 350 pots; or they have room for 600 pots and can increase the production, or there won't be enough to grow the crop at all.
- Bench diagrams are used by many growers to show what crops will be on a bench at what time of the year, and how much space each crop occupies. An illustration of a bench diagram is shown on the following page.

	Bench 3	Bench 2	Bench 1
January	Bulbs	Bulbs	Bulbs
February			
March	Bedding Plants	Bedding Plants	6" geraniums
April			
May		6" Pot Mums	Poinsettia Stock
June	Violets		
July			
August	6" Poinsettias	6" Poinsettias	6" Poinsettias
September			
October			
November			
December			

OBJECTIVE 4

Select from a list true statements about developing production records and maintaining a product inventory. (Supplement 1)

- It is critical that every grower keep accurate production and inventory records of all crops. These records help the grower decide what crops sell well, what colors or cultivars are popular, ideal propagation dates and target sales date. Without accurate, up-to-date records a grower will not know when mistakes have been made and will keep making the same mistakes.

- Crop production sheets should be kept on every cultivar grown at the greenhouse. A standard form can be designed and employees simply fill in the form as the crop develops.

  - These sheets can be kept in each greenhouse on waterproof clipboards, each grower or employee can have their own record book that they carry with them, or the sheets can be kept in a master file in the office.

  - Software packages are available for computerizing production records. Many of these programs are sophisticated enough to calculate dates cultural practices should be done; pinch, disbud, apply growth retardants, etc. They will also calculate production cost, keep inventory records and handle many other factors. These programs range in price from several hundred to several thousand dollars.

  - Any software program is only as good as the person who enters the data. Data must be entered every day if accurate records are to be kept.

  - Notes on cultivar performance, insect or disease problems, physiological problems and any other observations should be noted; it could become valuable information.

  - After several years of collecting data the grower should be able to develop an accurate production plan for the greenhouse. A sample crop production sheet is shown on the following page.

Crop: V-14 Glory Poinsettia Size: 6½ oz.

Date	Temperature		Cultural Treatment	Initials
	Day	Night		
8/20	80	75	Cuttings stuck in Oasis strips Used Hormex #1 powder	MA
8/27	80	75	drenched with 8 oz. NH_4NO_3 4 oz. Subdue 4 oz. Subdue	DW
9/3	80	68	Roots slightly developed; reduce mist. Start CLF 300 ppm N using Peters 20-10-20 PL.	TK
9/7	80	68	reduce mist further.	TK
9/13	75	68	Potrooted cuttings in 6½ pots. drench w/Banrot at 4 oz/100 gal Space pot to pot	MA
9/30	75	68	PINCH TO 5 NODES. APPLY MOLYBDENUM AND MAGNESIUM DRENCH	RN
10/11	75	66	Spray Cycocel 1500 ppm	MA
10/14	75	66	Monthly fungicide drench applied ½ oz Subdue + 4 oz Benlate /100 gal	MA
10/30	75	66	apply Molybdenum + magnesium sulfate drench	MA
11/15	72	64	Begining to see Color in bracts apply monthly fungicide drench	MA
12/6	72	64	Stop fert application	MA
12/10	72	64	Crop ready for sale	MA

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- Up-to-date product inventory records are necessary for accurate sales of the crop once it has been produced. Unfortunately, many growers never bother to count and keep track of the containers they have for sale. They rely on the "I saw a lot of 4" geraniums on the bench yesterday" method. When a customer calls and says they need 200 geraniums delivered on Friday, the grower says they have them and will be happy to supply them. Thursday evening the employees start packing the order and discover that there are only 98 quality pots on the bench; a major problem now exists. The 98 plants can be delivered with an apology, or the greenhouse can call the customer and tell them they don't have the plants, either way the customer is upset and probably won't buy from the greenhouse again!

- Inventory records must be kept during the entire production period. With accurate inventory records you will know exactly how many containers are on the bench at any given time. This accurate count of salable containers will tell you if your greenhouse has enough plants for your retail customers, if the greenhouse is short and needs to buy some from another grower, or if there are too many plants.

    - Inventory records can be as simple or as complicated as the grower desires; an employee counts the containers and writes it on a sheet of paper or a computer keeps track of what's left after each sale.

	6" geraniums - house 2	4 1/2" geraniums - house 2	606 flats Marigolds - hse 1	806 flats Vinca - hse 1	Petunia H. Bsk - hse 1
ap 1	108	350	98	105	84
3	97	299	90	97	60
5	70	260	81	84	42
7	43	194	80	60	25
8	21	175	76	50	-0-
9	17	94	72	43	75
10	4	86	64	20	70
11	-0-	50	56	13	52
12	-0-	41	34	-0-	48
13	100	34	29	-0-	34
14	84	22	19	-0-	21
15	61	12	4	50	19

- Like the software programs for production schedules, many inventory maintenance programs are available and they vary greatly in sophistication and cost. A partial list of the various programs currently available is given in Supplement 1.

- Inventory records also provide information on crop losses during production and when peak sales periods occur.

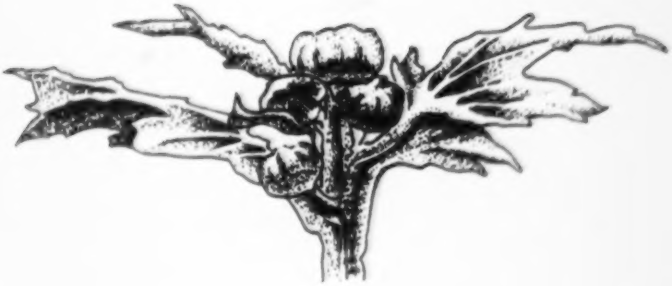
- Many people don't realize the greenhouse is overproducing a specific crop, or is producing a crop that isn't selling well, until they see inventory records. These records help them decide what crops to increase or decrease production or which crops to eliminate.

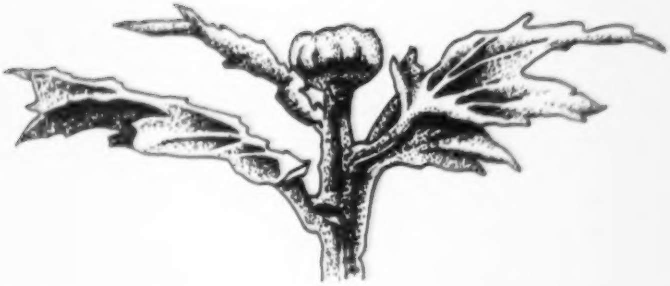
OBJECTIVE 5

Discuss pinching and disbudding plants.

Some plants require special cultural practices during production to produce visually attractive plants.

- Pinching—Removes the growing point of a shoot and eliminates the natural occurring hormones; when the hormones are absent the axillary buds break and develop.
  - A well branched plant that appears full is produced after the pinch.
  - Pinching should be done while the stem tissue is soft and immature.
  - Remove approximately the terminal 1/4" - 1/2" of the shoot when pinching. If the pinch is done late, and the tissue has already gotten woody, new branches will be slow to develop.
  - Pinching can be used to even up the height of a container that has several cuttings of various heights.





- Disbudding—Removes certain immature flower buds to improve the overall floral display of that shoot. Mums and carnations are two crops that must be disbudded.
  - By removing a portion of the flower buds from the shoot, the remaining buds develop into larger sized flowers and a more attractive display results.
  - Buds should be removed as soon as they are large enough to be handled.
  - Roll the small bud and peduncle downward with your thumbs while supporting the shoot tip with your remaining fingers. They should easily roll out of the leaf axil and the peduncle should snap off with the bud.
  - If disbudding is done too late, the peduncle will be difficult to remove and a visible wound will remain. The remaining flower buds may not fully expand.
  - There are three types of disbudding that can be done:
- **Center bud removal (CBR)**—Removes only the terminal flower bud from each shoot. This type of disbudding is used when spray type cut mums (many flowers on a single stem) or certain cultivars of pot mums are grown.

- **Lateral bud removal (LBR)**—Often called regular disbudding. This type of disbudding removes all lateral buds except the terminal bud on each shoot. This type of disbudding is used in carnation production, standard cut mum (one large flower per stem) production, and on certain cultivars of pot mums.

- **Multiple bud removal (MBR)**—A very soft pinch is made on each shoot after the buds have formed. This type of disbudding removes the terminal bud and a few of the apical lateral buds. It is recommended for certain cultivars that do not space their floral displays well.

  — Disbudding is usually done twice, one week apart. The second time gets the buds that were too small the first time or ones that were missed.

OBJECTIVE 6

Select from a list true statements about planning production schedules. (Supplement 2)

The scheduling of a crop is essential so the greenhouse staff will know when and how much bench space will be needed. In addition, planning and scheduling must be done to guarantee that a crop will be ready for sale at the proper time.

- Target sales dates should be decided upon first. All crop scheduling involves working backwards from the sales or finished date of the crop.

- Crop variability plays a major factor in determining the production schedule. Some crops can be started a few weeks before the sales date and others may require four months. A grower must be familiar with the requirements of each crop.

  — Plant and seed suppliers are good sources of scheduling information. Seed catalogs and trade magazines also offer helpful schedules on crop production. Make sure you are informed about the crop you plan on growing.

  — Scheduling a crop is a trial and error process the first few times a species is grown. After that the grower is familiar with the growth characteristics of the plant, and there are production records to use so the schedule can be fine tuned.

General schedule calculations for five types of crops are given below. Remember, these are only guidelines and should be used as tools when determining your own schedule.

- **Bedding plants**—A complete discussion on how to calculate bedding plant schedules for crops produced from seed is covered in unit 4.
  - For bedding plant crops that are propagated by cuttings the schedule will depend on whether rooted cuttings are being purchased, or if the greenhouse is going to root their own cuttings.
  - Rooting of cuttings generally takes 14-21 days. Determine how long rooting takes for your crop.
  - Pinching may or may not be needed on your crop. If pinching is done the plant will require an additional 7-14 days to flower; however, the pinched plant will be fuller, more attractive and usually bring a higher price.
  - The time of the year will also have an effect on how fast the crop is produced. Cuttings started in January will take longer to produce than cuttings started in March; the brighter days and warmer nights speed up the process.
  - This is a typical schedule for cutting produced geraniums using both rooted and nonrooted cuttings.

	Rooted Cuttings	Nonrooted Cuttings
Sale date	5-1	5-1
Retardant (if needed)	3-30	3-30
Pot cuttings	3-13	3-13
Stick cuttings	—	2-27

  - The rooted cuttings that were purchased required 2 weeks less greenhouse time and labor; 7 weeks total compared to 9 weeks total if the greenhouse rooted the cuttings.

- **Bulb crops**—Can be forced into bloom in pots and sold in the early spring. There are certain cultivars of tulips, daffodils and hyacinths that have been bred for pot forcing.

  NOTE: The Holland Bulb Forcer's Guide is a good reference book on forcing potted bulbs. This is a manual that gives detailed instructions on how to force these crops; it even has specific information for each cultivar.

  - All bulb crops require potting in the fall and then they must be chilled for a period of time. The grower must have access to a climate controlled cooler where the bulbs can be stored in the dark for several months.
  - This vernalization treatment is what causes the flower stalks to elongate and blooms to emerge when the pots are put in a warm greenhouse.
  - Most cultivars require 15 weeks of 40° F-45° F temperatures; however, this can vary from 12 weeks to 21 weeks depending on the cultivar.
  - When bulbs are potted the tip of the bulb should stick out of the media. They should be thoroughly watered, drenched with fungicide, and placed in a dark cooler. Check the pots at least once a week while in the cooler, and water as needed.
  - Tulips are potted 3 bulbs per 4" pot and 6 bulbs per 6" pot, hyacinths use 1 bulb per 4" pot and 3 bulbs per 6" pot, daffodils are usually only forced in 6" pots using 3 bulbs; there are a few new cultivars being introduced for 4" forcing.
  - After the vernalization treatment is over, move the pots to the greenhouse and force them at a pot to pot spacing with an average night temperature of 63° F-60° F.
  - The length of time in the greenhouse to force the plants will depend on the species and the time of year; tulips and daffodils require 4-5 weeks in January but only 2 weeks in April.
  - Growth retardants may or may not be needed depending on the cultivar; they are applied as a soil drench.

- Below is a typical schedule for tulips forced for Valentine's Day.

Sale date	February 7, 1993
Apply growth retardants	January 13, 1993
Pots in greenhouse	January 10, 1993
Pot bulbs and place in cooler	September 27, 1992

- **Foliage plants**—Production today commonly involves the use of specialized foliage producers in Florida and California. Economically it is cheaper for a greenhouse to either buy cuttings or tissue cultured finished plants from these specialized growers rather than try to produce their own plants.
  - Foliage plants are reasonably priced since many of them are propagated by tissue culture techniques.
  - A greenhouse grower saves time and labor by not having to propagate and then finish the foliage plants. A 6" dieffenbachia that is full can be purchased from a specialty grower for $3.50-4.00. It may take your greenhouse 9-10 months to produce a comparable plant.
  - Three months is considered average for the production of a quality 4-6" foliage plant depending on the species.
  - Foliage plants are easy to propagate and many techniques will work; air layering, division, stem tip cuttings. Some species are quick to root and grow and others are very slow.
  - When propagating foliage make sure the night temperature is at least 68° F and the cuttings have enough shade. Very few foliage plants can withstand high light intensities.
  - Most foliage plants are rooted 14 days after sticking and can be transplanted at that time. They often require several pinches to produce full plants.

- Below is a typical schedule for producing pothos hanging baskets

Sale date	August 1, 1992
Pinch	July 4, 1992
Pinch	June 6, 1992
Pinch	May 2, 1992
Stick 10 single eye cuttings/basket	March 28, 1992

- **Blooming pot plants**—Have been considered the bread and butter of the greenhouse industry. These plants are ones that are grown on a year round basis—mums, African violets, gloxinias, or for holidays—Easter lilies, poinsettias, hydrangeas.
  - These crops generally have a specific sale period and the grower must make sure that the plants are ready on time; no one wants to buy an Easter lily the day after Easter.
  - Seasonal and blooming pot plants generally require more specialized treatments to force them to bloom at a specific time; Easter lilies must be vernalized, mums must have the day length altered.
  - These crops are slightly more difficult to schedule because they are usually pinched, treated with growth retardants and require special fertilizers. It is very important that good records be kept on these crops during production.
  - The information below covers a seasonal and blooming pot plant.

- **Poinsettias**—are generally propagated in August and sold from Thanksgiving through Christmas.
  - A 6" or 6.5" pinched plant is the most commonly produced container.
  - Poinsettias require 8 - 10 weeks of short days to bloom depending on the cultivar.
  - When producing poinsettias be aware of these dates for Oklahoma production.

    September 1 - last day to propagate; except for 4" pots
    September 25 - plants established in final containers
    October 1 - last day to pinch plants
    October 10 - natural flower bud set occurs
    October 25 - last day to apply growth retardant

- Cuttings require 14-21 days to root.

- Here is a typical production schedule for poinsettias:

Bloom	November 26 - December 3
Growth retardant applied	October 17
Pinch	September 26
Transplant	September 5
Cutting stuck	August 15

NOTE: A good reference book for producing poinsettias is the Ecke Poinsettia manual. This book is written by the Ecke poinsettia staff and covers all aspects of poinsettia production.

- **Chrysanthemums**—are grown year round as blooming pot plants.
  - Mums are photoperiodic; they produce vegetative tissue under long days and initiate and form flowers under short day conditions.
  - Mums are classified and sold according to their response group; the weeks of short days required to induce flowering. They are also grouped according to how vigorously they grow; short types are the least vigorous, medium types are intermediate in growth and tall types are the most vigorous.
  - Specialized propagators sell rooted and unrooted mum cuttings to greenhouse growers who produce the potted plants. Very few growers maintain their own stock plants. Cuttings purchased from specialized growers are healthy, vigorous and inexpensive.
  - Depending on the time of year, a grower will have to either blackcloth or light the plants during production.
  - To make the plants produce vegetative growth, they are first grown under long days; if the days are naturally short, artificially light the plants from 10 p.m. till 2 a.m. Tall types will need 1 week of long days, medium types need 2 weeks and short types need 3 weeks.
  - To induce flower formation put the plants under short day conditions. If the days are naturally long, cover the plants with black cloth from 5 p.m. until 8 a.m. daily. Natural long days are from March 15 through September 15.

- Standard production practice puts five cuttings around the edge of a 6" pot. Make sure the cuttings are leaning against the pot *rim for support. They must be pinched* when roots have reached the bottom of the media; usually 10-14 days after potting.

- B-Nine, a growth retardant, may be required and should be applied when the new breaks are 1.5 - 2" long; usually 14 days after the pinch.

- Below is a typical schedule for a nine week medium pot mums cultivar:

Bloom date	April 2
Apply retardant	February 12
Begin short days	January 29
Pinch	January 25
Pot cuttings	January 15

- **Vegetables and herbs**—Vegetables are typically scheduled like bedding plants. Tomatoes, peppers, broccoli, cabbage, etc. are all produced from seed, and the seed catalogs give the same information on germination and timing as they do for bedding plants.

  - Herbs can be produced from either seed or cuttings. The method of production will depend on what herb is being grown. There are specialty herb growers that sell rooted cuttings or prefinished plants to greenhouse growers. This is usually a very economical way for greenhouses to produce herbs since they are usually grown in small quantities.

  - Below is a typical schedule for vegetable transplants:

Sale date	March 1
Transplant date	February 1
Sow date	January 22

OBJECTIVE 7 **Discuss proper acclimatization procedures.**

Once a crop is nearing the end of the production cycle it must be prepared for its ultimate environment.

- Hardening off is a procedure that prepares the plant for cold temperature. This treatment is done to cool season vegetables and bedding plants—broccoli, cabbage, pansies. The temperature in the greenhouse may be lowered or the plants can be moved to a cold frame to harden them. During this process they will need less water and fertilizer.

- Reducing fertilizer rates is especially important for blooming pot plants that will be used in the home environment. Under indoor conditions the plant will not be able to use high rates of fertilizers; excessive fertilizers can cause salt damage and shorten the life of the plant. Growers generally reduce or eliminate the fertilizer 1-2 weeks before the plant is sold.

- Lowering the amount of water is important in preparing bedding plants for the outdoor environment. Let the media get drier than it did during production; this hardens the roots and prepares them for the field soil. Also, reduce the rate of fertilizer.

- Decrease the light intensity on foliage plants. This will prepare them for the low light conditions of interiorscapes and will prevent them from dropping too many leaves. This process will take 4-6 weeks, and the light intensities should be gradually reduced. Fertilizer should be reduced at this time.

COMPUTER SOFTWARE

- ADS Software, (M.D.), Box 13686, Roanoke, VA 24036-3686. (703) 344-6818. US: (800) 672-4422.
- AFS Rosebud/Financial Software for Florists, Box 12309, Oklahoma City, OK 73157-2309. US: (800) 456-7890.
- Araos Software, 1485 W. Shaw Ave., Fresno, CA 93711. (209) 227-1000.
- Carlisle Systems Corp., 1449 Seneca Pl., Charlotte, NC 28209. (704) 527-6014.
- Condor Computing Inc., (M.D), Box 17276, Huntsville, AL 35810-7276. (205) 852-4490.
- Daisy System, The, 6108 Quince Rd., Memphis, TN 38119. (901) 767-0794.
- Data Enterprises Inc., (M.D). 526 Rt. 206, Trenton, NJ. (609) 298-8112.
- Data Planning Inc., 1012 16th Ave. N.W. Ste. 123, Surfside Beach, SC 29575. (803) 238-48344.
- DataRose Inc., 3ox 129, Bowling Green, KY 42102-0129. (502) 781-DATA. US: (800) 237-7030.
- Datasphere/Doane Info. Services Div. Control Data Corp., (M), 6443 S.W. Beaverton Hillsday Hwy., #305, Portland, OR 97221. (503) 297-9035.
- Dunn White Software Corp., (M.W.D). 300 S. Pine Island Rd. #242, Plantation, FL 33324. (305) 475-0708.
- Evergreen Systems Inc., 117 Illinois, Joliet, IL 60436. (815) 727-3900.
- Floral Solution Inc., The, 1118-1-30 Plaza, Ste. D. Greenville, TX 454-0071.
- Florist Automatic Data Systems, (M). 121 Sandy Bottom Rd., Coventry, RI 02816. (401) 822-3237. US: (800) 822-3238.
- Gardenware, (M.D). Box 130, Cannon Beach, OR 97110-1030. (503) 436-0612.

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- Great Plains Software, 1701 S.W. 38th, Fargo, ND 58103. (701) 281-0550.
- Hale Agency Systems Inc., 4009 Plainfield Ave. N.E. Grand Rapids, MI 49505. (616) 364-8761.
- Integral System Designs Inc., P.O. Box 2245. Doylestown, PA 18901-2245. (215) 340-0644.
- LANDCADD Inc., 7519 E. Hwy. 86, Franktown, CO 80116. (303) 688-8160.
- Long Island Greenhouses, Box 144, Hauppauge, NY 11788-0144. (516) 234-4943.
- Mahan & Assoc./Tig, 300 First St., Needham, MA 02194. (617) 449-6600.
- MiccaSoft Inc., 406 Windsor Ln., New Braunfels, TX 78132. (512) 629-4341.
- Micro Vane Inc., (M), 8135 Cox Dr., Kalamazoo, MI 49002. (616) 329-0188. US: (800) 222-0677.
- New ERA Software Design, (M.D). Drawer F. Smithtown, NY 11787. (516) 234-3917.
- Pneu Intl. Software (M.D). Box 64428, Virginia Beach, VA 234764-4428. (804) 420-7548. US: (800) 458-6189.
- Solve Inc., 419 Chester Ave., Annapolis, MD 21403. (301) 267-8400.
- Starcom Computer corp., 22121 17th Ave. S.E. Ste. 110 Bothell, WA 98201. (206) 486-6464.
- Systems Performance of America Ltd., 928 Crest, Wheaton, IL 60187. (312) 690-1868.
- Thornton Computer Management Systems, (D), 424 E. U.S. Hwy. 22 Maineville, OH 45039. (513) 683-8100. OH: (800) 582)-6129. US: (800) 543-7249.
- Triad Systems Corp., 3055 Triad Dr. Livermore, CA 94550. (415) 449-0606.

NOTE: Copies of Greenhouse Manager Magazine's Buyers' Guide are completely updated in the fall and spring of each year. Copies are available for $5.00 each from Greenhouse Manager, P.O. Box 1868, Fort Worth, TX, 76101.

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IMPORTANT DATES FOR POT PLANT PRODUCTION

INTRODUCTION

Although daily sales are important to a greenhouse, just as important are sales derived from holidays or special occasions. Listed below are some dates and the types of plants commonly sold. Also important are local events such as high school or university homecomings.

- **Valentine's Day**—(February 14)

  Azaleas, Potted Tulips, Miniature Roses

- **Easter Sunday**

  Easter Lily

- **Mother's Day**—(Second Sunday in May)

  Mums, Azaleas, Hydrangeas

- **Memorial Day**—(May 30)

  Geraniums, Mixed Annual Pots

- **Thanksgiving**—(Fourth Thursday in November)

  Christmas Cherry, Christmas Pepper, Mums

- **Christmas**—(December 25)

  Poinsettia, Azalea, Amaryllis, Christmas Cherry, Christmas Pepper

ASSIGNMENT SHEET 1

PRODUCING A CROP

VI

NAME ______________________ SCORE ________

OBJECTIVE 8 **Determine the space needed to grow a crop.**

INTRODUCTION Objective 3 discusses why it is important to know how much bench space will be needed to produce a crop. A grower has to calculate the space needed and then determine if there will be room for the crop in the greenhouses. The activity on this assignment sheet emphasizes this area.

DIRECTIONS Calculate the space requirements for the crops below and answer the questions.

1. How much bench space will be needed to grow 250 6" geraniums at an 8" x 8" spacing? ______________________

2. A grower has decided to direct seed marigolds into 11" x 22" flats using 606 cell packs. How much room will be required to grow 3600 plants at a flat to flat spacing? ______________

3. A greenhouse produces 4" African violets at a 4" x 4" spacing for 4 weeks and at a 6" x 6" spacing for the last 6 weeks. How many square feet weeks are required to produce a plant? ______________________

ASSIGNMENT SHEET 2 — PRODUCING A CROP — VI

NAME ______________________ SCORE ________

OBJECTIVE 9 **Calculate a production schedule for a crop.**

INTRODUCTION Objective 6 discusses how to plan a production schedule for various floriculture crops. Use the schedules in Objective 6 as a guideline.

DIRECTIONS Calculate a production plan for the crops listed below.

1. Tulips that will be ready for sale on March 1. Make sure to show the potting date, when the pots will come out of the cooler, when a growth retardant should be applied, and bloom date.

2. 6" pinched poinsettias that will be sold November 20. The cultivar you are using takes 9 weeks of short days to bloom. Make sure to include the date the cuttings should be taken, when they will should be potted, pinch date, when black clothing should be started, if needed, and the bloom date.

ASSIGNMENT ANSWERS — PRODUCING A CROP — VI

ASSIGNMENT SHEET 1

1. $\frac{8'' \times 8''}{144 \text{ sq. in/sq. ft.}}$ = (.44 sq. ft.) (250 pots) = 110 square feet needed

2. 606 packs produce 36 plants/flat
3600 plants needed = 100 flats must be grown
36 plants/flat

$\frac{11'' \times 22''}{144 \text{ sq. in./sq. ft.}}$ = (1.68 sq. ft./flat) (100 flats) = 168 sq. ft. needed

3. $\frac{4'' \times 4''}{144 \text{ sq. in./sq. ft.}}$ = (.11 sq. ft.) (4 weeks) = .44 sfw

6" x 6" = (2.5 sq. ft.) (6 weeks) = 1.5 sfw

.44 sfw + 1.5 sfw = 1.94 sfw total

ASSIGNMENT SHEET 2

1. — Bloom date—March 1
   — Apply growth retardant—February 4
   — Remove from cooler—February 1
   — Pot and put in cooler—October 19
2. — Sale date—November 20
   — Black cloth—September 18
   — Pinch—September 11
   — Pot cuttings—August 28
   — Stick cuttings—August 7

JOB SHEET 1

PRODUCING THE CROP

VI

OBJECTIVE 10a

Produce a foliage hanging basket.

INTRODUCTION

Every greenhouse employee should know how to pinch a plant so it appears full and healthy. The following procedure will demonstrate how pinching affects plant growth.

EQUIPMENT AND SUPPLIES

- Vine type foliage stock plant
- 8" hanging basket
- Rooting hormone
- Mist bench space

PROCEDURE

1. Harvest eight 3" long stem tip cuttings from a vine type foliage stock plant.
2. Treat the cut ends with rooting hormone.
3. Stick six cuttings around the outer edge of the basket and two in the center.
4. Label and date the basket and place it on the propagation bench.
5. Remove from the propagation bench when the cuttings have rooted.
6. Place in a production house with the proper light intensity. Pinch the tips of each stem.
7. Pinch the tips of all stems again in 4-5 weeks.
8. Repeat the process every 4-5 weeks until the basket is a salable size.

JOB SHEET 2 — PRODUCING A CROP — VI

OBJECTIVE 10b

Produce a crop of pot mums.

INTRODUCTION

Producing pot mums illustrates photoperiodic responses and the effect of disbudding. The grower will have to pinch, disbud and manipulate the day length if a successful crop is to be produced.

EQUIPMENT AND SUPPLIES

- Rooted mum cuttings of a medium type cultivar
- 6" pots
- Lighting system and blackcloth space
- B-nine

PROCEDURE

1. Place five rooted cuttings evenly along the outer edge of a 6" pot.
2. Water in and drench with fungicide.
3. Immediately begin growing the plants under long day conditions. Hand mist the cuttings several times a day for the first 1-2 days after potting to prevent them from severely wilting. Immediately begin a 300 ppm N CLF program using 20-10-20PL fertilizer.
4. Examine the plants after 10 days to see if the roots have reached the bottom of the pot. If they have, pinch the plants; if the roots are not to the bottom keep checking and pinch when they reach the bottom.
5. Transfer the plants to a bench that will provide short day conditions 14 days after the cuttings were potted.
6. Apply a 2500 ppm B-nine spray to the plants when the new shoots are 1.5 - 2" long. This is about 14 days after the pinch.
7. Disbud the plants when the buds are about 1/4" in diameter. Use center bud removal on one-half of the crop and regular disbudding on the other half of the crop. This will demonstrate the effect of the two disbudding methods.

JOB SHEET 1

Produce a foliage hanging basket.

Student's name ______________________ Date __________

Evaluator's name ______________________ Attempt no. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Harvested 8 3" long stem tip cuttings from a vine type foliage stock plant.	_____	_____
2. Treated the cut ends with rooting hormone.	_____	_____
3. Stuck 6 cuttings around the outer edge of the basket and 2 in the center.	_____	_____
4. Labeled and dated the basket and placed it on the propogation bench.	_____	_____
5. Removed the propogation bench when the cuttings had rooted.	_____	_____
6. Placed in a production house with the proper light intensity. Pinched the tips of each stem.	_____	_____
7. Pinched the tips of all stems again in 4-5 weeks.	_____	_____
8. Repeated the process every 4-5 weeks until the basket was salable size.	_____	_____

EVALUATOR'S COMMENTS

____

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key). A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Correctly harvested stem tip cuttings	4	3	2	1
Hormone properly applied	4	3	2	1
Cuttings correctly stuck	4	3	2	1
Basket labeled correctly	4	3	2	1
Basket pinched properly	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training

3 - Moderately skilled—Has performed job during training program; limited additional training may be required

2 - Limited skill—Has performed job during training program; additional training is required to develop skill

1 - Unskilled—Is familiar with process; but is unable to perform job

JOB SHEET 2

Produce a crop of pot mums.

Student's name ____________________ Date __________

Evaluator's name ____________________ Attempt no. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Placed 5 rooted cuttings evenly along the outer edge of a 6" pot.	_____	_____
2. Watered in and drenched with fungicide.	_____	_____
3. Grew plants under long day conditions, misted, and fertilized.	_____	_____
4. Properly pinched plants.	_____	_____
5. Transferred plants to a short day bench.	_____	_____
6. Applied a 2500 ppm B-nine spray to plants.	_____	_____
7. Properly disbudded the plants.	_____	_____

EVALUATOR'S COMMENTS

____

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key). A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Cuttings properly potted	4	3	2	1
Pinching completed at correct stage of growth	4	3	2	1
Growth retardant applied correctly	4	3	2	1
Disbudding done correctly	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training
3 - Moderately skilled—Has performed job during training program; limited additional training may be required
2 - Limited skill—Has performed job during training program; additional training is required to develop skill
1 - Unskilled—Is familiar with process; but is unable to perform job

WRITTEN TEST

PRODUCING A CROP

VI

NAME ______________________________ SCORE ________

OBJECTIVE 1

Match terms associated with greenhouse crop production to their correct definitions. Write the correct letters in the blanks.

____ 1. A treatment that exposes a plant or bulb to cold temperatures so flowers will develop

____ 2. A technique that removes immature flower buds from stem terminals to improve the floral display of the remaining buds

____ 3. A growing container that is 3/4 as tall as the top diameter

____ 4. Removing the apical growing point of a shoot, forcing it to branch

____ 5. Small growing container that is made from compressed peat moss and wood fiber

____ 6. A shallow growing container that is 1/2 as tall as the diameter

____ 7. A thin plastic growing container that is divided into individual compartments

____ 8. A growing container that is as tall as the top diameter

____ 9. Compressed peat moss disc enclosed by mesh that expands into a 1.5" growing container when it absorbs water

____ 10. A number that identifies how long a plant has been on the production bench and the square footage it occupied during that time

____ 11. A growing container that has holes around the edge where wires are attached so the container can be hung and the plants will cascade over the edges

a. Vernalization
b. Square feet weeks
c. Standard pot
d. Pinching
e. Prune
f. Peat pot
g. Jiffy pellet
h. Hanging basket
i. Disbudding
j. Cell pack
k. Common pack
l. Bulb pan
m. Belden basket
n. Azalea pot
o. Stratification
p. Nursery container

OBJECTIVE 2

Discuss selecting production containers. Answer the following questions in a brief, but complete manner.

1. What effect does your market have on the choice of production containers?

2. What is the most common production container for bedding plants, and why?

3. What crops are usually grown in peat pots?

OBJECTIVE 3

Calculate space requirements for crop production. Use the information and numbers given below to calculate the space requirements.

1. Greenhouse #3 has 3 benches 3′ x 59′ and 1 bench 3.5′ x 35.′ You plan on growing: 50 flats of petunias, 75 flats of vinca and 60 flats of marigolds all at a flat to flat spacing. 200 4" pots of begonia at a 5" x 6" spacing, 200 4" geraniums at a 7" x 7" spacing and 175 6" geraniums at a 9" x 9" spacing. 60 3" pots of various herbs will be grown at a 4" x 4" spacing and 30 large mixed planters will be produced at a 24" x 24" spacing.

   a. How much total bench space is available in greenhouse #3?

   b. How much bench space is needed to produce all the crops, and will they fit in house #3?

   c. Will there be any extra bench space left after the crops are on the bench; if so, how much?

2. 335 6" foliage plants will be grown at a 8" x 8" spacing for 17 weeks.

   How many square feet weeks will one pot use?__________

OBJECTIVE 4

Select from a list true statements about developing production records and maintaining a product inventory. Write an "X" in the blank before each true statement.

____ 1. Crop production records help a grower decide which cultivars sell best and what colors are popular.

____ 2. A standard crop production form can be used for all crops grown.

____ 3. Crop production records should always be kept in the office so they don't get wet.

____ 4. Data should be entered into the crop production records weekly.

____ 5. Computer software packages are available for maintaining crop production records.

____ 6. Product inventory records let the grower know how many containers are on the bench at any moment.

____ 7. Inventory records let the greenhouse staff know if a cultivar is being overproduced or underproduced.

____ 8. Product inventory should be taken once a month.

OBJECTIVE 5

Discuss pinching and disbudding plants.

1. Why are plants pinched during production?

2. How much stem tissue should be removed when pinched?

3. Define disbudding.

____

____

____

____

____

4. Distinguish between center bud removal and lateral bud removal.

____

____

____

____

____

OBJECTIVE 6

Select from a list true statements about planning production schedules. Write an "X" in the blank before each true statement.

____1. All production schedules work backward from the sales or finished date.

____2. Crop variability plays a major role in scheduling crops.

____3. Pinching has no affect on the flowering date of a bedding plants.

____4. The time of year has no affect on how fast a cutting will root.

____5. Tulips and daffodils are the only bulb crops that are forced into bloom for spring sales.

____6. Bulbs that are forced into bloom must be vernalized.

____7. Vernalization requires a temperature of 35° F.

____8. Foliage plants are commonly produced by purchasing rooted cuttings, or finished plants, from specialized foliage growers in Florida and California.

____9. When propagating foliage plants the night temperature should not be below 68° F.

___ 10. Blooming pot plants fall into two groups; those grown on a year-round basis and those produced for holidays.

___ 11. 6" poinsettias are generally propagated in September and sold from Thanksgiving through Christmas.

___ 12. October 31 is the last day to pinch poinsettias.

___ 13. Mums are photoperiodic; they produce flower buds under long day conditions.

___ 14. Plants can be tricked into thinking it is short days by black clothing them from 5 p.m. until 8 a.m.

___ 15. Vegetable transplants are produced using a schedule similar to bedding plants.

OBJECTIVE 7

Discuss proper acclimatization procedures.

1. How should broccoli and cabbage transplants be prepared for the outdoor environment?

2. How should you acclimate foliage plants for interiorscapes, and why are they acclimated?

NOTICE The following assignment sheets and job sheets are not part of the written test. If these activities have not been completed, check with your instructor.

OBJECTIVE 8 **Determine the space needed to grow a crop.** SCORE ________

OBJECTIVE 9 **Calculate a production schedule for a crop.** SCORE ________

OBJECTIVE 10 **Demonstrate the ability to**

a. **Produce a foliage hanging basket.** RATING ______

b. **Produce a crop of pot mums.** RATING ______

PRODUCING A CROP

VI

OBJECTIVE 1

1. a
2. i
3. n
4. d
5. f
6. l
7. j
8. c
9. g
10. b
11. h

OBJECTIVE 2

1. The greenhouse grower has to produce what his or her customers want to buy. Crops grown in a container that no one wants won't sell.
2. Cell packs. The consumer likes them because each plant has its own root system and they are easy to plant in the garden. The grower likes them because a lot of plants can be grown in a small amount of space.
3. Plants that don't transplant easily; cantaloupe, squash, watermelons, perennials.

OBJECTIVE 3

1. a.

$$\begin{aligned} (3)\,(3' \times 59') &= 531 \text{ sq.ft.} \\ (3.5' \times 35') &= \underline{122.5 \text{ sq.ft.}} \\ &\ 653.5 \text{ sq.ft.} \end{aligned}$$

b. 646 sq.ft. total space needed and they will fit in house #3.

$$\frac{(11'' \times 22'')}{144}\,(185) = 311 \text{ sq.ft.}$$

$$\frac{(5'' \times 6'')}{144}\,(200) = 42 \text{ sq.ft.}$$

$$\frac{(7'' \times 7'')}{144}\,(200) = 68 \text{ sq.ft}$$

$$\frac{(9'' \times 9'')}{144}\,(175) = 98 \text{ sq.ft.}$$

$$\frac{(4'' \times 4'')}{144}\,(60) = 7 \text{ sq.ft.}$$

$$\frac{(24'' \times 24'')}{144}\,(30) = 120 \text{ sq.ft.}$$

c. Yes; 7.5 sq.ft.

2. 7.6 sfw

$$\frac{(8" \times 8")}{144}(17 \text{ weeks}) = 7.6 \text{ sfw}$$

OBJECTIVE 4

1, 2, 5, 6, 7

OBJECTIVE 5

1. So they will branch and appear full.
2. About 1/4" inch-1/2."
3. The removal of some immature flower buds so the remaining floral display will be more attractive.
4. Center bud removal only removes the terminal bud of each shoot; lateral bud removal removes all buds except the terminal bud.

OBJECTIVE 6

1, 2, 6, 8, 9, 10, 14, 15

OBJECTIVE 7

1. Expose them to lower temperatures, also reduce water and fertilizer.
2. Gradually expose them to lower light intensities. This prepares them for the low light levels under indoor situations and prevents them from loosing their leaves when they go indoors. Reduce fertilizers also.

OBJECTIVE 8

Refer to answers to Assignment Sheet 1.

OBJECTIVE 9

Refer to answers to Assignment Sheet 2.

OBJECTIVE 10

Refer to Practical Test Ratings for Job Sheets 1 and 2.

OBJECTIVE SHEET — USING CHEMICALS IN THE GREENHOUSE — VII

INTRODUCTION

Standard production practices of commercial greenhouse crops involve the application of many different chemicals: growth retardants to control plant height, insecticides to control pest problems and fungicides to prevent disease. These materials must be properly applied to prevent damage to the crop, or injury to the applicator.

UNIT OBJECTIVE

After completing this unit, the student should be able to safely use chemicals. The student will demonstrate these competencies by completing an assignment sheet and written test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Select from a list true statements about licensing regulations and procedures.
2. Identify information on chemical labels.
3. Discuss applying chemicals safely.
4. Discuss preparing and maintaining a chemical application log.
5. Discuss choosing the proper chemicals.
6. Compute chemical cost.
7. Discuss developing and maintaining a chemical inventory.
8. Discuss mixing chemicals.
9. Discuss cleaning and maintaining chemical equipment.
10. Discuss storage of chemicals.
11. Describe proper disposal procedures for chemicals and chemical containers.
12. Design a chemical application log. (Assignment Sheet 1)

PREPARATION

- Obtain materials to supplement unit.

  NOTE: See Suggested Resources.

- Review instructional outline for this unit. Modify time frames to suit class needs and plan activities for each class period.

- Study the specific objectives to determine those you will cover in your presentation. Decide also which objectives should be taught to which students.

- Determine scope and sequence of objectives that you add. Design and develop support materials, including evaluation techniques, for additional objectives.

- Determine how you will schedule time for students to demonstrate competence in the required procedures.

- Make arrangements for guest speakers. Supply speakers with specific objectives and other appropriate sections of the unit.

- Check with school about any special chemical disposal regulations your school district or county may require.

- Make sure all safety gear is present for chemical application.

- Prepare warning signs in languages all students can read.

DELIVERY

Objective 1

- Introduce the topic of applying chemicals. Stress the importance of knowing how to properly handle chemicals.

- Discuss licensing regulations and procedures.

- Obtain information on your state's licensing requirements. In Oklahoma contact the State Department of Agriculture or your local county extension office.

- Obtain information on the Pesticide Applicator's License Test that is needed for your state.

  NOTE: For more information on pesticide use and regulations in Oklahoma contact Pesticide Coordinator, Oklahoma State University, 501 Life Sciences West, Stillwater, OK 74078-0285, phone 405-744-5531.

Objectives 2 through 4

- Discuss information on chemical labels.
- Bring sample chemical labels to class for students to examine.
- Discuss applying chemicals safely.
- Bring protective gear to class and give students the opportunity to wear it. Show students how to properly use a respirator.
- Discuss preparing and maintaining a chemical application log.

Objective 5

- Show students how to use the numerous charts and tables chemical companies publish as recommendations for pest problems.
- Give students a situation that has a pest problem and require them to use tables and charts to determine several alternative treatments.

Objective 6

- Discuss computing chemical cost.
- Give students various situations about chemical costs and have them calculate costs.

Objective 7

- Discuss the importance of developing a chemical inventory.
- Teach students how to take a chemical inventory.

Objectives 8 and 9

- Discuss mixing chemicals. Demonstrate the proper method to mix chemicals.
- Discuss cleaning and maintaining chemical equipment.

- Demonstrate the proper method for cleaning spray equipment.

Objectives 10 and 11

- Discuss storage of chemicals. Tour the chemical storage area of your greenhouse.
- Discuss proper disposal procedure for chemicals and chemical containers.

APPLICATION

Objective 12

- Use Assignment Sheet 1 to give students practice in designing a chemical application log.

EVALUATION

Written Test

- Explain to students that they will be asked to demonstrate on the written test actions listed in the specific objectives.
- Give written test.

  NOTE: Written test may be given in sections if desired.

- Evaluate students on assignment sheet activities if not previously done.
- Reteach and retest if necessary.
- Complete appropriate section of competency profiles.
- Review individual and group performance in order to evaluate teaching methods. Adjust scope, sequence, or instructional approaches for additional lessons as required.

SUGGESTED RESOURCES

Audiovisual Materials

- *Chemical Safety I*, 1/2" VHS, color, 20 min, Tel-A-Train, 1985. Available from Tel-A-Train, 307 N. Market St., Chattanooga, TN 37405, 615-624-2628. Stresses the importance of understanding the potential hazards a chemical may present, and of maintaining a safe attitude or prevention around hazardous substances. The viewer is introduced to labels and material safety data sheets (MSDS), then given eight rules to follow when working with chemical substances.

- *Chemical Safety II*, 1/2" VHS, color, 21 min., Tel-A-Train, 1985. Available from Tel-A-Train, 309 N. Market St., Chattanooga, TN 37405, 615-624-2628. The hazards of toxic exposure through inhalation, absorption, and ingestion are explained. The viewer is cautioned about situations which present special hazards, the importance of the proper mask or respirator is stressed.

NOTE: The above videos are available to Oklahoma teachers on a free-loan basis. Oklahoma teachers may order the videos from the Oklahoma Department of Vocational and Technical Education, Resource Center, ATTN: Instructional Media Specialist, 1500 West Seventh Avenue, Stillwater, OK 74074, 1-800-522-5810. Out-of-state teachers must order from the addresses listed with each video.

UNIT REFERENCES

- *Lab Safety Supply General Catalog*, Lab Safety Supply, Janesville, Wisconsin, 1989.
- Nesheim, Norm and Jim Criswell, *Toxicity of Pesticides* OSU Extension Facts No. 7457, Oklahoma State University Cooperative Extension Service, Stillwater, Oklahoma, 1982.
- Nelson, Paul V., *Greenhouse Operation and Management*, 3rd. ed., Reston Publishing Company, Inc., Reston, Virgina, 1985.
- Tayama, Harry K., *Floriculture Crops Insect and Mite Control, Disease Control, Growth Regulators, and Herbicide Booklet*, Ohio Florist's Association, Columbus, Ohio, 1989.

BASIC ACADEMIC SKILLS

The following table identifies the basic academic skills that are reinforced in this unit of instruction. These basic academic skills were identified using *The Basic/Essential Skills Taxonomy*, 2nd edition, and verified during the validation process.

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 1	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity
OBJECTIVE 2	Language Arts 013	Applies/Uses	Definitions	
	Language Arts 224	Identifies	Information-written	Key words/ phrases
OBJECTIVE 3	Language Arts 098	Composes/ Edits	Reports/ essays	Summaries
	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
OBJECTIVE 4	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
	Language Arts 136	Comprehends	Information-written	Charts/tables/ graphs
OBJECTIVE 5	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
	Language Arts 038	Collects/ Organizes	Information-oral/written	

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 6	Free Enterprise 118	Identifies	Cost	
	Mathematics 227	Solves problems	Fractions/ decimals/ ratio/percent	
	Mathematics 073	Computes	Multiplication	Whole numbers
	Mathematics 065	Computes	Multiplication	Decimals
	Mathematics 039	Computes	Division	Decimals
	Language Arts 136	Comprehends	Information-written	Charts/tables/ graphs
OBJECTIVE 7	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
OBJECTIVE 8	Mathematics 227	Solves problems	Fractions/ decimals/ ratio/percent	
	Language Arts 038	Collects/ Organizes	Information-oral/written	
	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
OBJECTIVE 9	Mathematics 254	Understands	Order of operation	Rules
	Language Arts 098	Composes/ Edits	Reports/ essays	Summaries
OBJECTIVE 10	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying

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	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 11	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
OBJECTIVE 12	Language Arts 136	Comprehends	Information-written	Charts/tables/ graphs
	Language Arts 049	Composes/ Edits	Audio-visual aids	
	Language Arts 272	Uses	Library resources	

OBJECTIVE 1

Select from a list true statements about licensing regulations and procedures.

All greenhouse employees who apply any type of chemicals should be licensed. This would ensure the public that an informed and responsible person is correctly using toxic materials. It also guarantees that greenhouse workers are aware of the dangers when using chemicals, and they understand the safety practices that should be used when applying chemicals.

- It is the responsibility of the greenhouse manager/grower to make sure each employee has the proper chemical applicator's license.
- Legal charges can be filed against the greenhouse manager/grower if employees are improperly applying chemicals. They are also at risk of being sued if an accident or injury should occur.
- The type of license needed depends on the state where the greenhouse is located.
- If restricted use chemicals are being used at the greenhouse one person must have a private applicator's license to purchase the chemicals. Companies will ask for, and record the employee's license number when restricted use chemicals are sold.
- Someone has to supervise employees while they are applying chemicals and that supervisor must have a private applicator's license. Legally, the supervisor must be in the same greenhouse as the applicator when they are applying chemicals.
- Any greenhouse employee who uses chemicals under the supervision of a licensed operator is not required to have a license.

  NOTE: It is strongly recommended that anyone who applies chemicals have a private applicator's license. This license will prove that the applicator has been trained in the use of chemicals and is aware of their dangers.
- A license covers the application of insecticides, fungicides, herbicide, growth retardants and any other "chemicals" used in the greenhouse industry.

- A written exam must be taken and passed to obtain a license. Once a license is received it is good for five years. The applicator must keep their license current either through Continuing Education Units or by taking the written exam again.
- Detailed information about your state's current requirements can be obtained from your State Department of Agriculture or from the county extension office. The State Department of Agriculture administers the exams and issues the license.
- The EPA (Environmental Protection Agency) is tightening and enforcing regulation on the use of chemicals on agricultural crops. Serious fines and jail sentences can be issued for improper application of chemicals.

OBJECTIVE 2

Identify information on chemical labels.

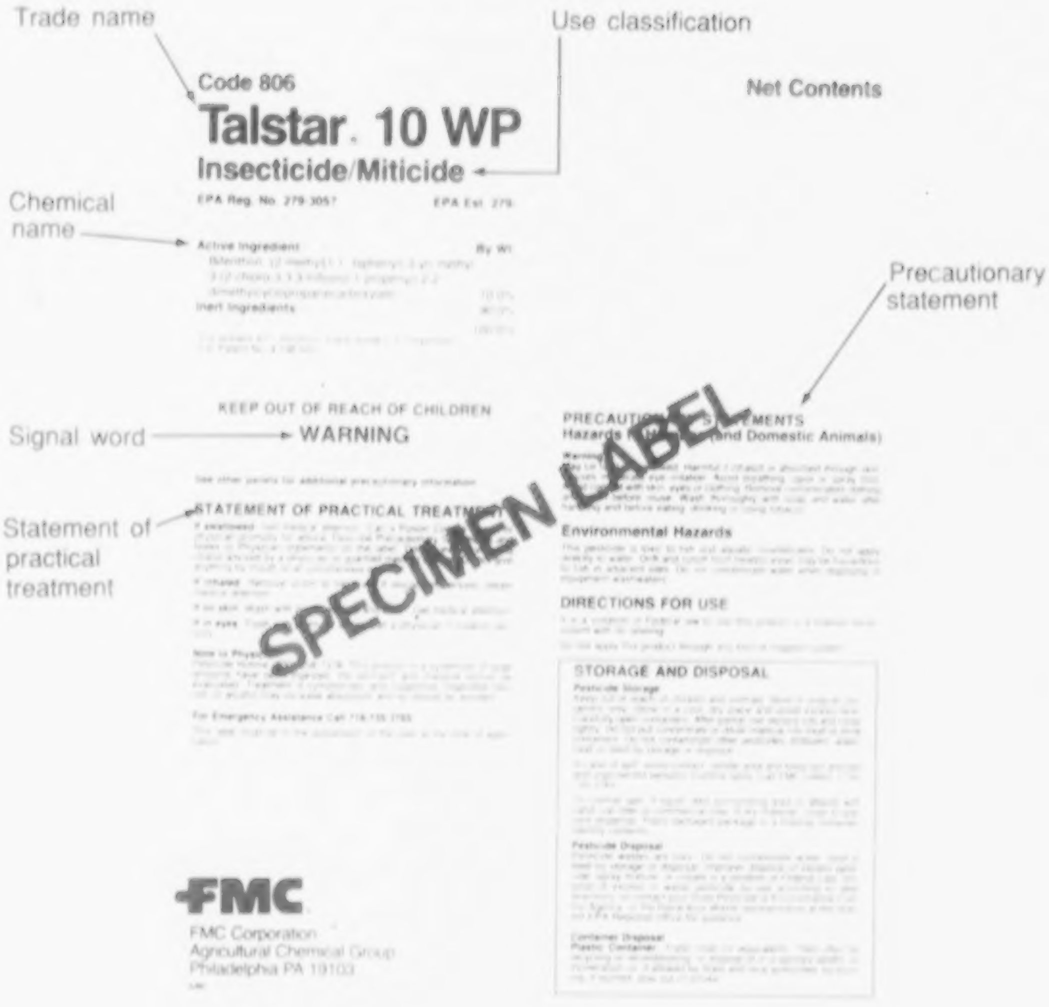
The label of any chemical must be read and understood before the material is used. Serious accidents and crop damage can be prevented if an applicator will read the label before applying.

Any applicator of chemicals must follow the directions written on the label or they can be charged with misapplication of chemicals.

A typical chemical label is shown on pages 14 and 15. Each applicator should be able to find the trade name, chemical name, signal word, precautionary statement, use classification, statement of practical treatment and re-entry statement.

- **Trade name** is the name the product is sold under; it is commonly known to the public.
- **Chemical name** is the technical chemical name given by a chemist.
- **Signal word** notifies the user how toxic the chemical is at a glance; caution is least toxic, warning is moderately toxic, and danger is highly toxic - it must have a skull and crossbones printed on the label.
- **Precautionary statement** describes the hazards of the material to humans, animals and the environment.
- **Use classification** states what type of chemical the material is; insecticide, fungicide, nematicide, etc.
- **Statement of practical treatment** tells what to do in case of over exposure or poisoning.

- **Re-entry statement** tells the period of time that must elapse before anyone can go back into the greenhouse. Not all chemical lables will have a re-entry statement.


Trade name
Use classification
Chemical name
Precautionary statement
Signal word
Statement of practical treatment
SPECIMEN LABEL

Code 806

Talstar. 10 WP

Insecticide/Miticide

Net Contents

EPA Reg. No. 279-3057 EPA Est. 279-

Active Ingredient By Wt

Inert Ingredients

KEEP OUT OF REACH OF CHILDREN

WARNING

See other panels for additional precautionary information

STATEMENT OF PRACTICAL TREATMENT

For Emergency Assistance Call 716-735-3765

PRECAUTIONARY STATEMENTS
Hazards to Humans (and Domestic Animals)

Environmental Hazards

DIRECTIONS FOR USE

STORAGE AND DISPOSAL

Pesticide Storage

Pesticide Disposal

Container Disposal

FMC

FMC Corporation
Agricultural Chemical Group
Philadelphia PA 19103

Used with permission of FMC Corporation.

Talstar® 10 WP Insecticide/Miticide

Greenhouse Grown
Ornamental Trees, Shrubs, Plants, and Flowers
Non-bearing Fruit and Nut Trees

DIRECTIONS FOR USE

Pest	Rate lb ai/ 10 gal	 oz/ 10 gal*	 scoops/ 10 gal	Comments
Aphids Armyworms Bagworm Brown Soft Scale Broad Mite California Red Scale (crawlers) Corn Earworm Cucumber Beetle Cutworms Elm Leaf Beetle Fall Webworm Flea Beetles Fungus Gnat Heliothis spp Lacebugs Leafhoppers Leaf feeding Caterpillars Loopers Mealybugs Oriental Fruit Moth Pine Needle Scale (crawlers) Pine Tip Moths Plant Bugs (including Lygus spp.) San Jose Scale (crawlers) Whiteflies	0.004 to 0.02	0.64 to 3.2	1½ to 9	Apply the specified rate as a full coverage foliar spray. Repeat as necessary to achieve control using higher rates as pest pressure and foliage area increases. Do not handle the plants until the spray has dried. To control Bagworm: Apply when larvae begin to hatch. Spray larvae directly. Applications made when larvae are young will be most effective. To control scale crawlers and twig borers: Treat trunks, stems, and twigs in addition to plant foliage. Certain cultivars may be sensitive to the final spray solution. A small number of plants should be treated prior to application of the entire planting. Use of an alternate class of chemistry in a treatment program is recommended to prevent or delay pest resistance.
Citrus Thrips Beet Armyworm European Red Mite Leafrollers Spider Mites Thrips Twig Borers	0.006 to 0.02	0.96 to 3.2	2¼ to 9	
Japanese Beetle Leafminers Pecan Leaf Scorch Mite	0.01 to 0.02	1.6 to 3.2	4½ to 9	

*1 Ounce of Talstar 10 WP by weight = 6 Tablespoons
1 pound of Talstar 10 WP = 9.6 cups
1 scoop (30 cc) = .36 oz Talstar 10 WP
1 scoop = 2 Tablespoons

Rate lb ai	Talstar® 10 WP Gallons of finished spray 1	 5	 10	 30	 50	 100
0.004	1t	5⅓t	3⅓T	10⅔T	1C	2⅓C
0.006	1⅓t	2⅔T	5⅓T	1C	1⅔C	3⅓C
0.010	2⅔t	4⅓T	9T	1⅔C	2⅔C	5⅔C
0.015	4t	6⅔T	13⅓T	2⅓C	4⅓C	8⅓C
0.020	5⅓t	9T	1C	3⅓C	5⅔C	11⅓C

t = teaspoon
T = Tablespoon
C = Cups

Dealers Should Sell in Original Packages Only.

Terms of Sale or Use: On purchase of this product buyer and user agree to the following conditions:

Warranty: FMC makes no warranty, expressed or implied, concerning the use of this product other than indicated on the label. Except as so warranted, the product is sold as is. Buyer and user assume all risk of use and/or handling and/or storage of this material when such use and/or handling and/or storage is contrary to label instructions.

Directions and Recommendations: Follow directions carefully. Timing and method of application, weather and crop conditions, mixture with other chemicals not specifically recommended and other influencing factors in the use of this product are beyond the control of the seller and are assumed by the buyer at his own risk.

Use of Product: FMC's recommendations for the use of this product are based upon tests believed to be reliable. The use of this product being beyond the control of the manufacturer, no guarantee, expressed or implied, is made as to the effects of such or the results to be obtained if not used in accordance with directions or established safe practice.

Damages: Buyer's or user's exclusive remedy for damages for breach of warranty or negligence shall be limited to direct damages not exceeding the purchase price paid and shall not include incidental or consequential damages.

- Chemical labels are important sources of information to the grower. They provide rates of application, how often the material can be used, what crops it can be used on and what adverse plant effects might occur.

- In case of accidental poisoning seek immediate medical attention. Take the chemical label or container with the victim to the hospital. It contains a note to the physician on how to treat the poisoning.

OBJECTIVE 3 **Discuss applying chemicals safely.**

Safe application of chemicals results in the target pest being controlled without injury or damage to the plants, or the applicator.

- Read the label. This is the first step in safely applying chemicals.
  - The suggested types of protective gear will be stated. The label also explains how the material is hazardous to the applicator and any special precautions that should be done before or after using the material.
  - Often the label will say when not to use the material because plant injury will likely occur.

    EXAMPLE: Do not use until 24 hours after high humidity conditions (rain or fog) or foliage injury will result, do not use on any species of ferns, etc.
  - Use the recommended application rates; more is not better! These chemicals have been thoroughly tested and the most effective rates are given on the label.
  - Follow the stated method of application. If the label says to incorporate or water the chemical into the media, don't apply it to the foliage. You are misapplying the material and could be held legally responsible; also, the chemical will not be effective in controlling your pest problem.
  - Observe the posted re-entry information.
- Wear the proper protective equipment to prevent chemicals from being absorbed by the applicator. Chemicals can enter the human body through oral exposure, dermal skin exposure, or inhalation exposure.

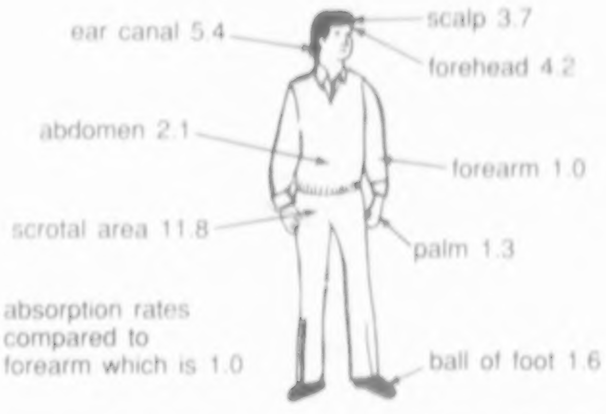
- The hazard of chemical exposure is determined by the toxicity of the chemical and the length of exposure. A relatively low toxicity chemical can be very hazardous if the length of exposure is for a long period of time.

- Oral exposure usually results from carelessness by the applicator. They somehow introduce the chemical into their mouth; a clogged nozzle is placed on the lips and blown through to remove the clog, smoking while applying chemicals or before washing hands after they have finished spraying, eating after applying chemicals but failing to thoroughly wash hands and arms.

- To prevent oral exposure never place anything in the mouth during chemical application. Smoking should never be allowed in the greenhouse. Immediately after application thoroughly wash face, hands and forearms with soap.

- Dermal exposure is the absorption of chemicals through the skin. The rate of absorption will depend on the chemical being applied, how much and how long the chemical is on the body, and what area of the body is exposed.

DERMAL EXPOSURE



absorption rates compared to forearm which is 1.0

Comparative rates of dermal absorption for different parts of the body

Courtesy of Oklahoma State University Cooperative Extension Service

- Dermal exposure can occur during the mixing or application of a chemical. Dry, liquid or granular chemicals can all be absorbed through the skin. If a chemical comes into contact with the skin immediately wash it off; do not wait "until the spraying is finished."

- If the applicator's clothes are contaminated with the chemical, remove the clothing and launder separately. Hot water and a strong detergent should be used; it is recommended pesticide contaminated clothes be washed twice.

- To prevent dermal exposure the applicator should wear protective clothing that covers the skin. Never allow an employee to spray chemicals wearing shorts, tee shirt and sandals; this is an accident waiting to happen.

- The toxicity of the material being sprayed will determine the type of protective clothing needed. If the material is very toxic, a rubber rain suit with hood will be necessary to protect the skin. For chemicals that have very low toxicities a long sleeved shirt, pair of long pants and a hat will be sufficient. Clothes should be removed and laundered as soon as the chemical application is completed.

- Rubber suits are very hot and uncomfortable for the applicator, especially in hot weather. Disposable paper suits with waterproof linings are popular because they are lightweight and cooler but still offer complete protection.

- Rubber gloves, rubber boots and goggles should always be worn when mixing and applying any type of chemical. The hands and feet have the greatest chance of being exposed to chemicals in the greenhouse and must be protected.

- Inhalation exposure results from breathing in vapors, fumes, dust or spray particles. This kind of exposure occurs during the mixing or application of chemicals without a protective mask, or by entering a treated area before the legal re-entry period.

- Do not burn empty chemical containers because they emit toxic vapors.

- A respirator should always be worn when mixing and applying chemicals. The type of respirator needed will depend on the chemicals being used. Usually, an organic vapor cartridge with a pesticide prefilter will be used with greenhouse chemicals.

- Make sure the respirator fits the applicator's face properly. Have the person put the respirator on and then take a deep breath inward; air should only enter through the intake cartridges and not around the respirator edges. Test kits are available that use strong smelling odors or smoke to check for leaks. If air leaks in, the respirator does not fit correctly and it is unsafe for the applicator to use. Another model, or size of respirator must be obtained and tested.

- Always clean and wash the respirator after each use.

- Some greenhouses will supply each applicator with their own respirator and spray suit; others have community suits and respirators.

- Post treated area so no one enters. A handwritten sign stating what chemical was used, the time of application, when it is safe to re-enter the area, and the name and phone number of who to contact in case of an emergency. Make sure a sign is put on every possible entrance to the treated area.

  - Instruct employees that no one is to enter a treated area before the safe re-entry period. If for some reason they must go in the area, full protective gear must be worn.

  - It is courteous to notify the fire department in advance when a fog or fumigant will be used in the greenhouse. Often a passing motorist will assume the greenhouse is burning and report it to the fire department.

OBJECTIVE 4

Discuss preparing and maintaining a chemical application log.

Keeping a precise and up to date record book of all chemicals applied at a greenhouse can be useful in crop production. It will be invaluable if any type of chemical contamination or spill occurs, or if someone files a complaint about your business using hazardous substances.

- The chemical application log should become part of the greenhouse's permanent records; keep it for at least five years.
  - A computer program can be used to design an application log. If a simpler log is desired, take a spiral notebook and draw columns for the data to be recorded. Anything will work as long as it can be permanently kept and is easy for the employees to fill out.
  - Always record the date of application, what chemical was used and how it was applied, the rate of material used, location where chemical was used, crop treated, amount of material prepared, amount of material left over after treatment, and the name of the applicator. Some growers prefer more detailed records.
  - The application log must be filled out every time any chemical, excluding fertilizers, is used at the greenhouse.

Date	Chemical	Rate	Method of Application	Location Used	Amt. Solution Prepared	Amt. Solution Remaining	Crops Treated	Applicator
1/6/90	Benlate	2gm/gal	spray	hse 2	2 gal	-0-	tulips	Mag
1/2/90	Tolstar	4.5gm/gal	spray	hse 5	4 gal	-0-	pecans foliage	Kim
2/1/90	Subdue Benlate	3gm/gal	drench	hse 1,2,&3	60gal	0	bedding plts, foliage, azaleas	Mag

Avoid Mistakes With Pesticide Use Reports

C. C. Powell
The Ohio State University
Department of Plant Pathology
2021 Coffey Road
Columbus, OH 43210

Every time I view a crop or planting that has been damaged by a pesticide, I am saddened to realize that a bit more attention to detail would probably have prevented the incident. Keeping good records is the best way to prevent mistakes. It is also a pretty good way to improve your chemical control knowledge and skills. Having to write down application techniques, dosages, materials used, etc. serves to emphasize their equal importance. Noting the effects of your actions can help you improve methods or evaluate the need for changes.

PESTICIDE USE REPORT

Please fill out this report each time a pesticide is applied *anywhere*: on plants, under benches, fumigants, baits, etc.

DATE OF APPLICATION ____________ TIME OF APPLICATION ____________

CONDITIONS: LIGHT ____________ TEMP ____________ WIND ____________

OTHER ____________

REASON FOR APPLICATION ____________

PESTICIDES USED ____________
(If more than one, list in order of tank mixing)

RECOMMENDED RATE: ________ RATE USED: Amount ________ Gallons of water ________

METHODS OF APPLICATION: (Mist blower, hydraulic sprayer, etc.) ____________

AREA APPLIED TO: (Field #, house #, bench #/ Note any plants not sprayed)

____

____

SIZE OF AREA (sq ft or acres): ____________

TOTAL GALLONS OR LITERS APPLIED ________ TOTAL AMOUNT OF PESTICIDE ________

RESULTS OF THIS APPLICATION: (record results several days after application).

Date: ________ Observation of pest control: ____________

Observation of any damage observed: ____________

____

YOUR NAME: ____________

COMMENTS:

PLEASE USE THIS AREA AND BACK OF THIS SHEET TO DO ALL CALCULATIONS FOR THIS APPLICATION:

Used with permission of Ohio Florists Association.

OBJECTIVE 5

Discuss choosing the proper chemicals.

Selecting the correct chemical for a cultural problem is like putting the proper key into a door lock; any key will not open your car, but when the proper key is inserted the door opens successfully. Chemicals work the same way; insecticides control insects and fungicides control fungi and neither one will retard plant height.

- Numerous tables and charts are available to growers recommending proper chemicals for pathogen control.
  - Many of the trade journals have such charts. They are the best source of information on new chemicals.
  - Charts can also be purchased from grower organizations such as the Ohio Florists' Association or Professional Plant Growers Association to name a few.
  - Extension personnel at the county or state level are excellent sources of information if you are unsure of what chemical to use.
  - Local growers associations are good sources of information and advice. These groups are made up of growers and industry representatives from your local communities and state.
  - Floriculture books on crop production always list suggested chemical control methods.
  - Chemical labels must be read. They will tell the grower if the material will control the pathogen of interest and if the chemical is labeled for the crop you want to use it on.
  - Every greenhouse should have charts or tables available so employees can check to see if they have the correct chemical at the proper rate.
- Rotate chemicals so pests do not build up a resistance to the chemical. Do not use the same chemical for more than a month; switch to another chemical that will control the pest after a month. Some growers only use a chemical two times in a row and then switch to another chemical.

OBJECTIVE 6 **Compute chemical cost.**

Every grower likes to know what the production cost for a crop is, and the cost of chemicals must be added into that figure.

- Determine the cost of a gram or milliliter of the chemical and then see what it costs to make a gallon of solution.
  - Subdue fungicide costs \$48.25 for a quart and is used at a rate of 0.5 oz./100 gallons. What is the cost per 1 gallon of subdue solution?

    1 quart = 944 milliliters   1 oz. = 29.5 milliliters

    $\frac{\$48.25}{944\text{ml}} = \$0.05/\text{ml}$

    $(29.5 \text{ ml/oz})(.5 \text{ oz}) = 14.75 \text{ ml/100 gal}$

    $(14.75 \text{ ml/100 gal})(\$0.05/\text{ml}) = \$0.74/100 \text{ gal of solution}$

    $\frac{\$0.74/100 \text{ gal}}{100 \text{ gal}} = \$0.0074/\ 1 \text{ gallon of subdue solution}$

  - This method of calculation can be used to find the cost of any chemical solution. However be careful when trying to compare two different chemicals to each other. If they are both applied using the same method then the cost can be compared. However, it is difficult to compare the cost of a drench material to a spray chemical.
  - Growth retardants are hard to compare cost because they are applied using different techniques.

OBJECTIVE 7 **Discuss developing and maintaining a chemical inventory.**

A chemical inventory helps the grower make sure all necessary chemicals are available and that they are of usable quality.

- Develop records that will quickly allow a person to see how much of each chemical is on the shelf.
  - Separate inventory sheets should be kept for fungicides, insecticides, growth retardants and miscellaneous chemicals.
  - Inventory sheets should indicate how much of each chemical is on the shelf and available for use.

- Update inventory records on a monthly basis. Someone will have to physically audit all chemical containers in the chemical storage room.
  - Monthly audits tell the grower what chemicals are available and how much chemical is being used during the month.
  - By keeping inventory records the greenhouse should never run out of a chemical. It should also prevent over purchasing a product.
  - Inventory records allow the grower to estimate the total chemicals used during a year. Discount prices may be received if chemicals are purchased in one large order.

Insecticides				
	Jan	Feb	March	April
Avid	1 pint	0.5 pt	2 pts	1.5 pt
Depel	1 lb	1 lb	0.5 lb	0.5 lb
Insecticidical soap	1 gallon	3/4 gal	1/4 gal	4 gal
Oxamyl	4 lbs	3 lbs	0.5 lbs	8 lbs
Resmethrin	2 pints	1.5 pts	1.25 pts	1.0 pts
Talstar	1 lb	3/4 lb	1/4 lb	2 lbs

OBJECTIVE 8

Discuss mixing chemicals. (Supplements 1 through 3)

The chemical must be calculated for the amount of solution you need. These materials are very expensive so only the amount of solution needed should be prepared. Proper techniques must be used to make a solution that will be easy to apply and will work properly.

- Calculate the amount of chemical needed. Most chemical rates are expressed as the amount of chemical required to make 100 gallons of solution. Very rarely is 100 gallons of material needed for greenhouse crops.
  - Mathematical proportions can be used to calculate the amount of material needed for a small solution volume.

- The label says to use one pound per 100 gallons. The employee only needs three gallons of spray; how much chemical is needed for three gallons?

$$\frac{16 \text{ oz chemical}}{100 \text{ gal}} = \frac{X \text{ oz chemical}}{3 \text{ gal}}$$

  .48 oz chemical = X

- All chemicals should be measured using the metric scale. If the chemical is a dry material convert ounces to grams; multiple ounces by 28.35 to get grams. If the material is a liquid convert it to milliliters; multiply ounces by 29.5

  .48 oz. of a dry chemical = 13.6 grams (.48)(28.35)

  .48 oz. of a liquid chemical = 14.2 milliliters (.48)(29.5)

- Growth retardants are usually expressed as either a ppm solution or as milligrams per pot.

- Tables are available with the amounts of material needed to make a desired growth retardant solution.

• Prepare the chemical by weighing a dry chemical or measuring a liquid chemical.

WARNING: Mask, rubber gloves, goggles and protective clothing must be worn while preparing the sample. Dry chemicals give off dust and liquids emit fumes. Also, the chemical is in a concentrated form so its toxicity is concentrated.

- Plastic bags are good for weighing powders. They are lightweight yet hold a lot of chemical.

- A graduated cylinder will be needed to measure liquid chemicals. For liquid chemicals that require 1 milliliter or less per gallon, a three to five cc syringe works well for accurately measuring very small amounts of chemicals, and they can be reused. These can be purchased from any agriculture supply store that sells veterinary supplies.

- After a chemical has been measured, close the container and put it back in the chemical storage room. Wipe down the counter or table and scale, and put the scale away.

- Mix the chemical by dumping the sample into a one or two gallon bucket that contains several inches of water.
  - Stir thoroughly to dissolve the chemical. Liquid chemicals are easy to mix but dry materials are more difficult. They have a tendency to form lumps; make sure all the lumps have been broken up and no dry chemical is sticking to the bottom of the bucket.
  - After the chemical has been dissolved in the small amount of water add the rest of the water to make the desired solution volume.
  - This solution can be poured into the sprayer. Many growers pour the chemical solution through a strainer or screen to prevent any debris from clogging the nozzles of the sprayer.
  - NEVER dump chemicals directly into a sprayer and add water. It will not mix thoroughly and could clog the sprayer.
- Immediately apply the material. Many chemicals are destroyed by sunlight after they are prepared. They can lose strength if not used soon after preparation
  - Do not mix any chemical solution unless it can immediately be applied.
- Clean up all equipment and areas that were used to mix the chemicals. Wash off the buckets, stirring sticks, lab benches, protective gear and anything else that was used to make the solution.

OBJECTIVE 9 **Discuss cleaning and maintaining chemical equipment.**

Chemical application equipment needs to be cleaned and serviced like any other piece of mechanical equipment. If the machinery is not cared for properly it will work improperly and its life will be shortened.

- Read all instructions and know what type of service or maintenance the equipment needs. Many people do not read the manual until a piece of machinery breaks.
- Perform yearly servicing on all equipment.
  - Gasoline powered engines should be tuned up at the beginning of the heavy use season. Make sure the oil and filters are changed.

  - All sprayers should have the nozzles thoroughly cleaned at the beginning of the season. It is also a good time to replace any cracked or leaking gaskets or seals.
  - Replace any cracked, kinked or damaged hoses on the spray equipment.
  - Order any spare parts that will be needed during the coming year. This eliminates the equipment "being down until the part gets here."
  - Make sure pumps are oiled if required.
  - Wheels should be greased for easy movement of the equipment.

- Clean equipment after each use. The best way to guarantee that a piece of equipment will work the next time it is needed is to make sure it works after each use.

- Sprayers should be thoroughly washed immediately after use.

  1. Fill the spray tank 1/3 - 1/2 full of warm soapy water.
  2. Agitate the water so the inside of the tank is washed, and then pump the soapy water through the hoses and nozzles.
  3. Dump the soapy water and refill the tank with warm ammonia water.
  4. Agitate and pump this solution through the hoses and nozzles.
  5. Dump the solution and double rinse the sprayer with clear water. Make sure the water is pumped through the nozzles each time.
  6. Hang small sprayers upside down so they can drain and dry. For larger sprayers leave the lid off so the tank can dry. Cover the opening with some kind of cloth so dirt and debris will not fall into the tank.

  Also, if the nozzles were not producing the correct spray pattern remove and thoroughly clean them. Most nozzles can be soaked in food grade phosphoric acid for five to 10 minutes.

- Store equipment where it will not freeze. If the equipment is likely to freeze, run an antifreeze solution through the equipment before storage.

- A separate sprayer should always be used for herbicides. Never use this sprayer for any other type of chemical application. Label an herbicide sprayer and a chemical/fungicide sprayer and use the correct sprayer when applying materials.
  - It is acceptable to use the same sprayer for insecticide and fungicide application.

OBJECTIVE 10 **Discuss storage of chemicals.**

All chemicals at a greenhouse must be stored so the safety of every person at the greenhouse is guaranteed.

- A locked storage area must be used to store chemicals. This ensures that unauthorized people will not be exposed to chemicals.

  CAUTION: This area should ideally remain between 40-70° F. Some chemicals are ruined if they are exposed to freezing temperatures or bright light.

- A sign must be clearly posted on the chemical storage facility so that anyone can tell this is where chemicals are kept.
  - Labeling is very important to persons unfamiliar with the greenhouse.

    EXAMPLE: Firefighters and emergency medical persons who are in the area because of a fire or other emergency situation

- An exhaust vent should be installed in the chemical storage room so the fumes and vapors are drawn outside.
  - A high concentration of fumes can build up in a closed area. It is hazardous for an employee to go into the chemical storage area if there are high concentrations of fumes.

- Shelving should be provided to keep the chemicals organized and prevent them from getting wet.
  - Ideally each type of chemical should have its own area in the chemical storage room; fungicides are on the top shelf, insecticides are on the bottom shelf and growth retardants are in the cabinet.

- Tightly close all chemical containers. This keeps the materials fresh and extends their shelf life. It also prevents excess fumes from building up in the storage facility.
  - Lids should be tightly sealed on all jars, plastic bottles and canisters.
  - Chemicals in paper or foil lined bags should have the top rolled shut and held in place with a clip type clothespin. Place the closed paper bag inside a clear plastic bag and twist tie the plastic shut.
  - Plastic bags help keep moisture out and contain the fumes. It is easy to read labels through the plastic bags.
- Date all containers of chemicals when they arrive. This lets the applicator know how old the material is, and the grower knows if employees are using the oldest chemicals first.

OBJECTIVE 11

Describe proper disposal procedures for chemicals and chemical containers.

Chemicals and chemical containers are considered hazardous substances and must be properly destroyed to prevent harm to humans or the environment.

- Prepared chemical solutions can only be disposed of by applying them to labeled crops.
  - Prepare only the amount of chemical solution required to treat the target crop.
  - Money is being wasted if too much solution is prepared; the excess chemical costs money; the labor to mix and apply the extra solution also costs money.
  - The target crop may be over treated if the applicator has extra spray material they must get rid of; crop injury could result and another loss of money occurs.

- Chemical containers must be empty before a grower can discard them.
  - Bottle and jar type containers should be completely empty. After the chemical is removed, triple rinse the container with clear water. This rinsate should be returned to the spray equipment and applied to labeled crops. Puncture holes in the container after it has been rinsed and dispose of it in a sanitary landfill. Puncturing holes prevents children on anyone else from placing liquids in the bottle.
  - Bag type containers should have all dry chemicals removed. Discard the container in a sanitary landfill.
- Old chemicals or chemicals that are no longer usable cannot be placed in sanitary landfills. A private company that disposes of toxic materials must be hired to dispose of these chemicals.

OHIO FLORISTS ASSOCIATION BULLETIN

DISEASE CONTROL CHART*

C. C. Powell, Extension Plant Pathologist, The Ohio State University

DISEASE	CHEMICAL CONTROL			REGISTERED CROPS	USES**	COMMENTS
	COMMON NAME	BRAND NAME	FORMULATION			
Powdery mildews (cont.)	Picro cupric ammonium formate and tannate complex	Phyton 27	5.5EC	Roses	OU	Mix carefully. Begin with lower dosage and increase as needed.
	Piperalin	Pipron	82.4EC	Chrysanthemum, dahlia, lilac, phlox, rose, zinnia	OU	
	Sulfur	Flotox	90 Dust or WP	Chrysanthemum, dahlia, rose	OU	May burn foliage if temperature high (90 to 95° F) at time of application
		Sulfur	95 Dust/or WP	Calendula, chrysanthemum, dahlia, delphinium, phlox, rose, sweet pea	OU	
	Thiophanate-methyl + Mancozeb	Zyban Duosan	75WP	Kalanchoe, phlox, rose, stock, zinnia	OU GH	
	Triadimefon	Bayleton TOF	25DF	Ageratum, azalea, begonia, carnation, chrysanthemum, dahlia, delphinium, gardenia, geranium, hollyhock, pansy, petunia, phlox, rose, salvia, sedum, snapdragon, sunflower (ornamental only), zinnia African violet, calendula, carnation, chrysanthemum, cineraria, crassula, daisy, geranium, gerbera, grape ivy, kalanchoe, rose, snapdragon	OU GH	Do not exceed labeled rates or frequencies
	Triforine	Triforine	18.2EC	Calendula, dahlia, phlox, snapdragon, rose, zinnia	OU GH	
Bacterial diseases	Streptomycin	Agri-Step	21.2WP	Chrysanthemum-bacterial wilt	OU	
		Agrimycin	21.2WP	Dieffenbachia-bacterial stem rot Philodendron-*Xanthomonas* leaf rot Rose-crown gall	OU	Soak cuttings 20 minutes Plant dip
	Fixed Coppers Bordeaux mixture	Bordeaux Mixture	12.75WP	Geranium-leaf spot	OU	
		Bordo-Mix	12.75WP	Chrysanthemum-leaf spot	OU	
	Cupric hydroxide	Kocide 101	77WP	Aralia, begonia, carnation, ivy, philodendron-bacterial leaf spots	OU GH	
	Picro cupric ammonium formate and tannate complex	Phyton 27	5.5EC	Cyclamen-soft rot	OU	Mix carefully

---

*This list is presented for information only. No endorsement is intended for products mentioned, nor is criticism meant for products not mentioned. Before purchasing and using any growth regulator, you must check all labels for registered use, rates, and application frequency. It is illegal to use any pesticide in a manner inconsistent with the labeling.

**OU = Outdoor Use and GH = Greenhouse Use.

Used with permission of Ohio Florists' Association.

MAKING DESIRED GROWTH RETARDANT SOLUTION

Table 2. A-Rest dosages, concentrations, and dilutions – Growing medium drench *
0.0264% a.i.; 0.264 mg. a.i. per milliliter

Dosage – milligrams (mg) per pot at given volume									Concentration	Dilution	
Drench Volume (oz)	1	2	3	4	5	6	8	10	ppm	oz/gallon of solution	ml/liter of solution
	0.020	0.04	0.063	0.08	0.110	0.125	0.17	0.21	0.7	0.35	2.7
	0.040	0.08	0.126	0.17	0.210	0.250	0.34	0.42	1.4	0.68	5.3
	0.075	0.15	0.225	0.30	0.375	0.450	0.60	0.75	2.5	1.30	9.5
	0.150	0.30	0.450	0.60	0.750	0.900	1.20	1.50	5.0	2.50	19.0

* Locate the desired dosage in the column under the appropriate drench volume. Find the corresponding dilution in the dilution columns.

Table 3. A-Rest concentrations and dilution – Foliar spray
0.0264% a.i.; 0.264 mg. a.i. per milliliter

Concentration	Dilution	
ppm	oz/gallon of solution	ml/liter of solution
10	4.9	38
25	12.1	95
33	16.0	125
50	24.2	190
66	32.0	250
100	48.5	380
132	64.0	500
200	97.0	760

Table 5. Benzyladenine (BA) dilutions to provide a 100 ppm foliar spray

Dilution for 100 ppm*		
100 milligrams	in	1 liter water
500 milligrams	in	5 liters water (1.3 gal)
1 gram	in	10 liters water (2.6 gal)
5 grams	in	50 liters water (13.2 gal)
25 grams	in	250 liters water (66.1 gal)

* Dilute first in smaller volume of grain alcohol to dissolve BA, then use distilled water to provide the rest of volume needed.

Table 7. Bonzi concentrations and dilutions – Foliar spray
0.4% a.i.; 4.0 mg. a.i. per milliliter

Concentration	Dilution	
ppm	oz/gallon of solution	ml/liter of solution
10.00	0.32	2.5
25.00	0.80	6.3
31.25	1.00	7.8
46.90	1.50	11.7
50.00	1.60	12.5
62.50	2.00	15.5
75.00	2.40	18.8
93.75	3.00	23.4
100.00	3.20	25.0

Used with permission of Ohio Florists' Association

Table 5. B-Nine SP or Alar 85 concentrations and dilutions – Foliar spray. 85% a.i. 850 mg. a.i. per gram

Concentration	Dilution		
ppm	Level scoops/ gallon of solution*	oz/gallon of solution	grams/liter of solution
750	1 small	0.11	0.88
1,500	1 large	0.23	1.76
2,500	2 large	0.40	2.94
5,000	4 large	0.80	5.88
7,500	6 large	1.20	8.82

* Approximate dosage only. Measuring scoop provided with product has a large and small end. Use weight measurements wherever possible.

Table 9. Cycocel concentrations and dilutions – Foliar spray or growing medium drench. 11.8% a.i. 118 mg. a.i. per milliliter

Concentration	Dilution	
ppm	oz/gallon of solution	ml/liter of solution
1,000	1.1 8.5	
1,500 *	1.6	12.7
2,000	2.2	17.0
2,500	2.7	21.2
3,000 **	3.3	25.4
4,000	4.4	34.0
5,000	5.4	42.4

* Also referred to as 1 to 80

** Also referred to as 1 to 40

Table 8. Bonzi concentrations and dilutions – Growing medium drench. 0.4% a.i. 4.0 mg a.i. per milliliter

Concentration	Dilution	
mg. per 6-inch pot	oz/gallon of solution	ml/liter of solution
0.125	0.03	0.26
0.188	0.05	0.39
0.250	0.07	0.52

U.S. TO METRIC CONVERSIONS

1 ounce = 28.35 grams

1 pound = 454 grams

1 fluid ounce = 29.5 milliliters

1 gallon = 3785 milliliters

ASSIGNMENT SHEET 1

USING CHEMICALS IN THE GREENHOUSE

VII

NAME ______________________________ SCORE ________

OBJECTIVE 12

Design a chemical application log.

INTRODUCTION

Objective 4 discusses the importance of keeping track of the chemical applications at a greenhouse. Chemical records aid greenhouse personnel in making sure a good chemical rotation program is being used, and they will also be very valuable if a chemical accident ever occurs.

DIRECTIONS

Use the example chemical log in Objective 4 to design your own chemical log for your school's greenhouse.

ASSIGNMENT SHEET 1

Use the following criteria for evaluation:

- The log must include the following:
  - chemical applied
  - date applied
  - who applied the chemical
  - where it was used and on what crop
  - how much chemical was prepared and the rate if applicable
  - material that was left over
- The log should be neat and easy to read.
- It should be easy for an employee to fill out.

NAME ______________________________ SCORE ________

OBJECTIVE 1

Select from a list true statements about licensing regulations and procedures. Write an "X" in the blank before each true statement.

____ 1. A greenhouse grower can be charged with improperly applying restricted chemicals if there is not at least one person at the greenhouse with a private applicator's license.

____ 2. A private applicator's license only covers the applicator when they are applying insecticides and fungicides.

____ 3. Private applicator's licenses are good for three years.

____ 4. A written test must be taken to get a pesticide applicator's license.

____ 5. A person can keep their private applicator's license current through Continuing Education Units.

____ 6. Pesticide applicator's licenses are issued by the EPA.

____ 7. It is the responsibility of the greenhouse manager/grower to make sure each employee has the proper chemical applicator's license.

____ 8. Anyone can purchase restricted use chemicals.

____ 9. No legal charges can be filed for improperly using chemicals.

____ 10. The type of license needed depends on the state where the greenhouse is located.

OBJECTIVE 2

Identify information on chemical labels. Answer the following questions from the chemical label given.

1. What is the trade name for this chemical?

____

2. What signal word is given on the label?

____

3. Give the use classification for this material.

____

Code 806

Net Contents

Talstar® 10 WP

Insecticide/Miticide

EPA Reg. No. 279-3057 **EPA Est. 279-**

Active Ingredient:	**By Wt.**
Bifenthrin, (2 methyl[1,1'-biphenyl]-3-yl) methyl 3-(2-chloro-3,3,3-trifluoro-1-propenyl)-2,2-dimethylcyclopropanecarboxylate*	10.0%
Inert Ingredients:	90.0%
	100.0%

*Cis isomers 97% minimum, trans isomers 3% maximum
U.S. Patent No. 4,238,505

SPECIMEN LABEL

KEEP OUT OF REACH OF CHILDREN

WARNING

See other panels for additional precautionary information.

STATEMENT OF PRACTICAL TREATM[illegible]

If swallowed: Get medical attention. Call a Poison Co[illegible] or physician promptly for advice. Describe Precautionary S[illegible] and Notes to Physician statements on the label. Do[illegible] in[illegible] v[illegible] unless advised by a physician or qualified me[illegible] not give anything by mouth to an unconscious p[illegible].

If inhaled: Remove victim to fre[illegible] If disco[illegible] persists, obtain medical attention.

If on skin: Wash with [illegible] and [illegible] Get medical attention.

If in eyes: Flush [illegible] nty [illegible] all a physician if irritation persists.

Note to Physic[illegible]
Pesticide Hotline (800[illegible]58-7378. This product is a pyrethroid. If large amounts have be[illegible] ingested, the stomach and intestine should be evacuated. Treatment is symptomatic and supportive. Digestible fats, oils, or alcohol may increase absorption and so should be avoided.

For Emergency Assistance Call 716-735-3765.

This label must be in the possession of the user at the time of application.

FMC

FMC Corporation
Agricultural Chemical Group
Philadelphia PA 19103

6/89

PRECAUTI[illegible] ST[illegible]EMENTS

Hazards [illegible] H[illegible] (and Domestic Animals)

Warning
[illegible]ay be fa[illegible]owed. Harmful if inhaled or absorbed through skin. [illegible]uses m[illegible]erate eye irritation. Avoid breathing vapor or spray mist. A[illegible]d co[illegible]t with skin, eyes or clothing. Remove contaminated clothing an[illegible] before reuse. Wash thoroughly with soap and water after han[illegible]ing and before eating, drinking or using tobacco.

Environmental Hazards

This pesticide is toxic to fish and aquatic invertebrates. Do not apply directly to water. Drift and runoff from treated areas may be hazardous to fish in adjacent sites. Do not contaminate water when disposing of equipment washwaters.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

Do not apply this product through any kind of irrigation system.

STORAGE AND DISPOSAL

Pesticide Storage
Keep out of reach of children and animals. Store in original containers only. Store in a cool, dry place and avoid excess heat. Carefully open containers. After partial use replace lids and close tightly. Do not put concentrate or dilute material into food or drink containers. Do not contaminate other pesticides, fertilizers, water, food or feed by storage or disposal.

In case of spill, avoid contact, isolate area and keep out animals and unprotected persons. Confine spills. Call FMC collect (716) 735-3765.

To confine spill: If liquid, dike surrounding area or absorb with sand, cat litter or commercial clay. If dry material, cover to prevent dispersal. Place damaged package in a holding container. Identify contents.

Pesticide Disposal
Pesticide wastes are toxic. Do not contaminate water, food or feed by storage or disposal. Improper disposal of excess pesticide, spray mixture, or rinsate is a violation of Federal Law. Dispose of excess or waste pesticide by use according to label directions, or contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA Regional Office for guidance.

Container Disposal
Plastic Container: Triple rinse (or equivalent). Then offer for recycling or reconditioning, or dispose of in a sanitary landfill, or incineration, or, if allowed by State and local authorities, by burning. If burned, stay out of smoke.

Used with permission of FMC Corporation.

Talstar* 10 WP Insecticide/Miticide

Greenhouse Grown
Ornamental Trees, Shrubs, Plants, and Flowers,
Non-bearing Fruit and Nut Trees

DIRECTIONS FOR USE

Pest	Rate lb ai/ 10 gal	 oz/ 10 gal*	 scoops/ 10 gal	Comments
Aphids Armyworms Bagworm Brown Soft Scale Broad Mite California Red Scale (crawlers) Corn Earworm Cucumber Beetle Cutworms Elm Leaf Beetle Fall Webworm Flea Beetles Fungus Gnat Heliothis spp Lacebugs Leafhoppers Leaf-feeding Caterpillars Loopers Mealybugs Oriental Fruit Moth Pine Needle Scale (crawlers) Pine Tip Moths Plant Bugs (including Lygus spp.) San Jose Scale (crawlers) Whiteflies	0.004 to 0.02	0.64 to 3.2	1¾ to 9	Apply the specified rate as a full coverage foliar spray. Repeat as necessary to achieve control using higher rates as pest pressure and foliage area increases. Do not handle the plants until the spray has dried. To control Bagworm: Apply when larvae begin to hatch. Spray larvae directly. Applications made when larvae are young will be most effective. To control scale crawlers and twig borers: Treat trunks, stems, and twigs in addition to plant foliage. Certain cultivars may be sensitive to the final spray solution. A small number of plants should be treated prior to application of the entire planting. Use of an alternate class of chemistry in a treatment program is recommended to prevent or delay pest resistance.
Citrus Thrips Beet Armyworm European Red Mite Leafrollers Spider Mites Thrips Twig Borers	0.006 to 0.02	0.96 to 3.2	2¼ to 9	
Japanese Beetle Leafminers Pecan Leaf Scorch Mite	0.01 to 0.02	1.6 to 3.2	4½ to 9	

*1 Ounce of Talstar 10 WP by weight = 6 Tablespoons
1 pound of Talstar 10 WP = 5.6 cups
1 scoop (30 cc) = .36 oz Talstar 10 WP
1 scoop = 2 Tablespoons

Rate lb ai	Talstar* 10 WP/Gallons of finished spray					
	1	5	10	30	50	100
0.004	1t	5⅓t	3¾T	10¾T	1C	2¼C
0.006	1¾t	2¾T	5⅓T	1C	1¾C	3½C
0.010	2¾t	4½T	9T	1¾C	2¾C	5⅔C
0.015	4t	6¾T	13½T	2½C	4¼C	8½C
0.020	5⅓t	9T	1C	3½C	5⅔C	11¼C

t = teaspoon
T = Tablespoon
C = Cups

Dealers Should Sell in Original Packages Only.

Terms of Sale or Use: On purchase of this product buyer and user agree to the following conditions:

Warranty: FMC makes no warranty, expressed or implied, concerning the use of this product other than indicated on the label. Except as so warranted, the product is sold as is. Buyer and user assume all risk of use and/or handling and/or storage of this material when such use and/or handling and/or storage is contrary to label instructions.

Directions and Recommendations: Follow directions carefully. Timing and method of application, weather and crop conditions, mixture with other chemicals not specifically recommended and other influencing factors in the use of this product are beyond the control of the seller and are assumed by the buyer at his own risk.

Use of Product: FMC's recommendations for the use of this product are based upon tests believed to be reliable. The use of this product being beyond the control of the manufacturer, no guarantee, expressed or implied, is made as to the effects of such or the results to be obtained if not used in accordance with directions or established safe practice.

Damages: Buyer's or user's exclusive remedy for damages for breach of warranty or negligence shall be limited to direct damages not exceeding the purchase price paid and shall not include incidental or consequential damages.

OBJECTIVE 3

Discuss applying chemicals safely.

1. How does oral pesticide exposure usually occur?

2. What type of protection is used to prevent dermal pesticide exposure?

3. Why are disposable pesticide suits popular?

4. How can you test a respirator to see if it fits properly?

5. Each greenhouse that is treated with pesticide must have a sign posting that a chemical application has been made. What information should be on that sign.

OBJECTIVE 4 **Discuss preparing and maintaining a chemical application log.**

1. How can a chemical application log help a grower maintain a chemical rotation plan?

2. Do fertilizer applications have to be recorded in a chemical application log?

OBJECTIVE 5 **Discuss choosing the proper chemicals.**

1. Why should chemicals be rotated at least once a month?

2. Name three sources of information that can be used to determine what chemicals are needed to treat a pathogen.

OBJECTIVE 6 **Compute chemical cost.**

1. Calculate the cost of four gallons of Banrot solution. The labeled rate for Banrot is eight ounces per 100 gallons, and a two pound bag of Banrot cost $49.60.

____

____

____

____

2. Which insecticide is cheaper to use; Talstar at 16 ounces per 100 gallons and it cost $58.95 per pound, or Pentac at eight ounces per 100 gallons and it cost $62.96 per quart (32 ounces or 944 milliliters)

____

____

____

____

OBJECTIVE 7 **Discuss developing and maintaining a chemical inventory.**

1. How often should chemical inventories be updated?

____

____

____

____

2. How do chemical inventory records help a grower buy chemicals at a cheaper price?

____

____

____

____

OBJECTIVE 8 **Discuss mixing chemicals.**

1. How many grams of Benlate is needed to make 35 gallons of a fungicide solution when the rate is 8 ounces per 100 gallons?

2. What type of protective gear must be worn while weighing out chemicals?

3. How many milliliters of A-Rest must be mixed per gallon to produce a 33 ppm spray solution?

4. Describe how to properly prepare a spray solution using a wettable powder type chemical.

5. Why must chemical solutions be immediately applied?

OBJECTIVE 9 **Discuss cleaning and maintaining chemical equipment.**

Describe the proper procedure for cleaning a sprayer after use.

OBJECTIVE 10 **Discuss storage of chemicals.**

1. Describe the requirements for a safe chemical storage area.
2. How should opened paper bags of chemicals be stored?

3. Why should the date be written on all chemicals?

OBJECTIVE 11

Describe proper disposal procedures for chemicals and chemical containers.

1. What do you do with the extra insecticide solution left in the sprayer after spraying a crop?

2. How should you dispose of an empty plastic insecticide bottle?

3. How should you dispose of an empty fungicide paper container?

4. What do you do with a bottle of Orthene that froze last winter and is no longer usable?

NOTICE The following assignment sheet is not part of the written test. If this activity has not been completed, check with your instructor.

OBJECTIVE 12 **Design a chemical application log.** SCORE ________

WRITTEN TEST ANSWERS

USING CHEMICALS IN THE GREENHOUSE

VII

OBJECTIVE 1

1, 4, 5, 7, 10

OBJECTIVE 2

1. Talstar 10 WP
2. Warning
3. Insecticide/Miticide

OBJECTIVE 3

1. The applicator accidentally puts it in their mouth; they smoke or eat without washing their hands, or they may blow on a clogged nozzle.
2. Wear a protective suit with hat, rubber gloves, rubber boots, and goggles.
3. They are lightweight and cool compared to plastic suits.
4. Put it on your face and take a deep breath in. If air enters along the edges of the respirator it does not fit properly. You can also buy test kits that use strong scented materials to test for leaks.
5. The name of the chemical that has been applied, when it was applied, when it is safe to enter the greenhouse and who to contact in case of an emergency.

OBJECTIVE 4

1. It is easy to check to see what chemicals have been applied the last few times.
2. No

OBJECTIVE 5

1. So the pest does not build up a resistance to the chemical.
2. Answer should include any three of the following:
   - Trade journals
   - Growers associations
   - Extension specialist
   - Floriculture books
   - Chemical labels
   - Tables and charts from chemical companies

OBJECTIVE 6

1. 50 cents

   $$\frac{8}{100\text{ gal}} = \frac{X}{4\text{ gal}}$$

   $X = .32$ oz

   $$\frac{\$49.60}{32\text{ oz}} = \$1.55/\text{oz}$$

   (.32 oz)($1.55/oz) = $0.496/oz = $.50/4 gallons of solution

2. Pentac is cheaper

   Talstar cost $58.95/ 100 gallons of solution

   Pentac cost $15.74/ 100 gallons of solution

   $$\frac{\$62.96}{32\text{ oz}} = \$1.97/\text{oz}$$

   ($1.97/oz)(8 oz/100 gal) = $15.74

OBJECTIVE 7

1. Once a month
2. Chemicals are cheaper when bought in a large volume. Inventory records tell you how much chemical is needed for a year.

OBJECTIVE 8

1. $$\frac{8\text{ oz}}{100\text{ gal}} = \frac{X}{35\text{ gal}}$$

   $X = 2.8$ oz

   (2.8 oz)(28.35 gm/oz) = 79.4 grams

2. Gloves, respirator, goggles and sleeves to cover the arms.
3. 472 milliliters

   (16 oz)(29.5 ml/oz) = 472 milliliters

4. Weigh out the wettable powder.

   Put it in a bucket that has several inches of water in it.

   Stir the solution until all the lumps have dissolved.

   Make sure none of the powder sticks to the bottom of the bucket.

Add the rest of the water to make the correct volume of solution.

5. Many of them break down when exposed to light.

OBJECTIVE 9

1. Fill the spray tank 1/3 - 1/2 full of warm soapy water.
2. Agitate the water so the inside of the tank is washed, and then pump the soapy water through the hoses and nozzles.
3. Dump the soapy water and refill the tank with warm ammonia water.
4. Agitate and pump this solution through the hoses and nozzles.
5. Dump the solution and double rinse the sprayer with clear water. Make sure the water is pumped through the nozzles each time.
6. Hang small sprayers upside down so they can drain and dry. For larger sprayers leave the lid off so the tank can dry. Cover the opening with some kind

OBJECTIVE 10

1. It must be locked.

   It has to have a sign on it stating "Chemical storage."

   It should protect chemicals from freezing temperatures.

   Fumes should be vented outdoors with exhaust fan. It should have shelves to keep chemicals from getting wet.

2. Roll the top closed.

   Hold it in place with a clip clothespin.

   Put the bag inside a clear plastic bag.

   Shut plastic bag with a twist tie.

3. So the grower knows how old the chemicals are and can make sure older chemicals are being used first.

OBJECTIVE 11

1. It must be applied to a labeled crop; it cannot be dumped out.
2. – Use all the chemical.

   – Triple rinse the empty bottle with clear water and pour rinsate into sprayer.

   – Puncture a hole in the rinsed bottle

- Discard in trash; it can go to a sanitary landfill.

3. - Shake out all the chemical.
   - Place it in the trash; it can go to a sanitary landfill.
4. - Hire a toxic waste disposal company to dispose of it.

OBJECTIVE 12 Refer to answers to Assignment Sheet 1.

OBJECTIVE SHEET

IDENTIFYING AND CONTROLLING PESTS IN THE GREENHOUSE

VIII

INTRODUCTION

Greenhouse crops are susceptible to attack from various pathogens. The warm, moist greenhouse environment encourages the reproduction of insects and the spread of disease. A grower must be able to recognize and identify a pest problem before control measures can be applied.

UNIT OBJECTIVE

After completing this unit, the student should be able to recognize common greenhouse pests and apply the correct control methods. The student will demonstrate these competencies by completing an assignment sheet and written test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Select from a list true statements about pest problems.
2. Distinguish between the types of management techniques for pest problems.
3. List methods of chemical application.
4. Complete statements about the correct time for chemical application.
5. Select from a list true statements about identifying chemical injury to plants.
6. Develop a chemical shopping list. (Assignment Sheet 1)

PREPARATION

- Obtain materials to supplement unit.

  NOTE: See Suggested Resources.

- Review instructional outline for this unit. Modify time frames to suit class needs and plan activities for each class period.
- Study the specific objectives to determine those you will cover in your presentation. Decide also which objectives should be taught to which students.
- Determine scope and sequence of objectives that you add. Design and develop support materials, including evaluation techniques, for additional objectives.
- Determine how you will schedule time for students to demonstrate competence in the required procedures.
- Make arrangements for guest speakers. Supply speakers with specific objectives and other appropriate sections of the unit.
- Develop a collection of insect pests preseved in jars of alcohol.

DELIVERY

Objective 1

- Discuss pest problems.
- Show students examples of pests preserved in alcohol.

Objective 2

- Discuss with students the different types of management approaches a grower can use to control pests.
- Ask students to give the pros and cons of each management technique.

Objectives 3 through 5

- Discuss the methods of chemical application. Show students examples of the different kinds of chemicals.
- Discuss the correct times for chemical application.
- Present students with various situations and have them discuss which methods of control they would use, and why. They will need to refer to tables and charts for the proper chemical if that is their method of choice.
- Discuss chemical injury to plants.

APPLICATION

Objective 6

- Use Assignment Sheet 1 to give students practice in developing a chemical shopping list.

EVALUATION

Written test

- Explain to students that they will be asked to demonstrate on the written test actions listed in the specific objectives.
- Give written test.

  NOTE: Written test may be given in sections if desired.

- Evaluate students on assignment sheet activity if not previously done.
- Reteach and retest if necessary.
- Complete appropriate section of competency profiles.
- Review individual and group performance in order to evaluate teaching methods. Adjust scope, sequence, or instructional approaches for additional lessons as required.

SUGGESTED RESOURCES

Audiovisual Materials

- *Chemical Safety I*, 1/2" VHS, color, 20 min, Tel-A-Train, 1985. Available from Tel-A-Train, 309 N. Market St., Chattanooga, TN 37405, 615-624-2628. Stresses the importance of understanding the potential hazards a chemical may present, and of maintaining a safe attitude of prevention around hazardous substances. The viewer is introduced to labels and material safety data sheets (MSDS), then given eight rules to follow when working with chemical substances.

- *Chemical Safety II*, 1/2" VHS, color, 21 min., Tel-A-Train, 1985. Available from Tel-A-Train, 309 N. Market St., Chattanooga, TN 37405, 615-624-2628. The hazards of toxic exposure through inhalation, absorption, and ingestion are explained. The viewer is cautioned about situations which present special hazards, the importance of the proper mask or respirator is stressed.

NOTE: The above videos are available to Oklahoma teachers on a free-loan basis. Oklahoma teachers may order the videos from the Oklahoma Department of Vocational and Technical Education, Resource Center, ATTN: Instructional Media Specialist, 1500 West Seventh Avenue, Stillwater, OK 74074, 1-800-522-5810. Out-of-state teachers must order from the addresses listed with each video.

BASIC ACADEMIC SKILLS

The following table identifies the basic academic skills that are reinforced in this unit of instruction. These basic academic skills were identified using *The Basic/Essential Skills Taxonomy*, 2nd edition, and verified during the validation process.

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 1	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity
	Science 460	Identifies	Cycles	Biological
	Language Arts 013	Applies/Uses	Definitions	
	Science 482	Identifies	Organisms	Insects
OBJECTIVE 2	Language Arts 013	Applies/Uses	Definitions	
	Language Arts 139	Comprehends	Information-written	Context
OBJECTIVE 3	Language Arts 132	Comprehends	Information-written	
	Language Arts 038	Collects/ Organizes	Information-oral/written	
OBJECTIVE 4	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 013	Applies/Uses	Definitions	
	Science 382	Describes/ Explains	Plants	Parts/ functions

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 5	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity
OBJECTIVE 6	Language Arts 272	Uses	Library resources	
	Mathematics 229	Solves problems	Generate conclusions	Deductive reasoning
	Mathematics 034	Computes	Addition	Whole numbers

INFORMATION SHEET

IDENTIFYING AND CONTROLLING PESTS IN THE GREENHOUSE

VIII

OBJECTIVE 1

Select from a list true statements about pest problems.

The first step to quickly solving a cultural problem in the greenhouse is to correctly identify the problem. If a grower is unsure of the cause of the problem they cannot accurately choose a method of correction.

Recognizing the causes of greenhouse crop problems is important. A grower must be able to recognize the symptoms and identify the problem. Is it a disease, insect, nutritional, or environmental problem?

Only after the correct cause is identified can the proper control or environmental conditions be implemented. Applying fungicides to control aphids is a waste of time and money.

NOTE: Nutritional problems were discussed in unit five and a list of common deficiency and toxicity symptoms were included.

Environmental problems are commonly caused by improper light intensities, extreme temperatures, high humidity levels, improperly vented heaters or vapors from herbicides or other chemicals.

Disease can be a problem in the greenhouse since it is a warm, wet environment. If you suspect a disease problem, read literature to see what diseases are common to the crop.

- Fungal diseases are the most prevalent in the greenhouse, although bacteria and virus can cause problems. A few of the most common fungal diseases are described below.
    - Damping off of seedlings is common during or shortly after germination. The young stems develop a dark area near the media surface and the seedlings fall over. They look like someone snipped them off with a knife. This disease is usually caused by Rhizoctonia, but it can be due to Pythium or a combination of both fungi.

      The pathogen is spread by humans through contaminated media, tools, propagation bench, etc.

      A media drench of Terraclor, Subdue, Benlate, Banrot, or Chipco 26019 may help control the problem. Use Terraclor only once during propagation.

Using fungicide treated seed, or treating the seed yourself, will reduce damping off problems.

- Powdery mildew is a fungal disease that produces a white powdery mildew growth on the surface of leaves, petals and occasionally on stem tissue. It is easy to see the threads of the fungi spreading over the leaf surface. If the problem becomes severe the plants will be unsalable due to distorted growth and unattractive foliage.

  The spores of powdery mildew are carried by wind currents and quickly infect nearby plants with the disease. These spores are able to germinate and grow in high humidity environments. For these reasons powdery mildew spreads quickly in a greenhouse unless some treatment is applied.

  Foliar sprays quickly control powdery mildew. However, if the plants are in a high humidity environment they will need repeated applications of fungicides to control the disease.

  Bayleton TOF, Benlate, Karathane, Milban, Triforine and Sulfur are all labeled for control of powdery mildew.

- Botrytis is a rotting of plant tissue and it produces a gray fuzzy mold on the affected tissue. It is common on leaf, petal and stem tissue of plants in poor health; healthy plants are rarely attacked.

  The spores are easily carried on air currents but only germinate in the presence of water.

  Control can be obtained by constantly removing dead or damaged flowers and foliage. Keeping the plant foliage as dry as possible, and limiting condensation in the greenhouse will help reduce the botrytis problem.

  Fungicides that help contain botrytis are Exotherm Termil, Benlate, Daconil 2787, Chipco 26019 and Ornalin.

- Pythium root rot is a fungal organism that lives in the growing media and attacks almost every plant species. It causes a blackening of the roots which later become slimy and eventually collapse. The disease thrives in cool, wet soils that drain poorly.

  Using a porous, well drained media does a lot to limit the pythium problem. Keeping plant media on the dry side will also limit pythium diseases.

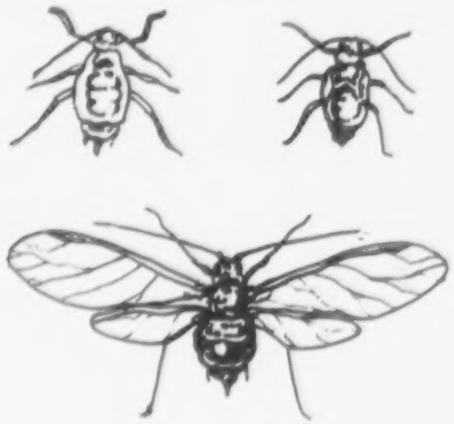
Soil drenches of Truban, Subdue, Benlate and Lesan can be used on a monthly interval to prevent root rot problems.

Insects will also be a problem in the greenhouse due to warm, humid conditions. Because the temperature is so warm, insects reproduce year round at accelerated rates. A grower must be able to quickly identify an insect outbreak and begin proper control treatments.

- **Aphids** are soft bodied insects that usually attack the young growing parts of a plant; the buds, shoot tips and newly expanding leaves.
  - Green peach aphids are the most common species found in the greenhouse. They are lime green in color and are major pests in the spring and fall. Most adults are wingless. However, if a colony becomes too crowded, or food is in short supply, they will develop wings and fly to a new area and begin a new colony.
  - Aphids can be year-round pest problems in the greenhouse. These pests reproduce every seven to ten days without mating, and each adult can produce 50-75 offspring.
  - Aphids have a piercing-sucking mouth part that sucks the juices from a plant. As they feed they secrete a honeydew that coats the plant; it is very shiny and sticky. A black sooty mold will grow on this honeydew and the plants become unsalable.

- Orthene, Talstar, Pt 265 Knox-Out, Vapona and Safers Soap are a few of the pesticides that will help control aphids.

  NOTE: Aphids are easily identified by the twin cornicles on their posterior end.



Green Peach Aphid

USDA sketch.

- **Mealybugs** appear as white cottony masses. They are usually found in the axils of leaves and on newly expanding tissue.
  - The citrus mealybug has a piercing-sucking mouth part that injects a poison into the plant when it is pierced. This poison will cause the foliage to be chlorotic and distorted. A honeydew is also secreted and sooty mold grows on the honeydew.
  - Mealybugs can reproduce by either laying eggs or giving birth to live nymphs, depending on the species. The nymphs move around and feed on the plant for six to eight weeks before becoming an adult.
  - Nymphs are easiest to control because they have not developed a waxy coat. It is difficult to control adults because they are protected by the waxy covering.
  - Surfactants should be used with wettable powder insecticides to help them adhere to the mealybug's body.

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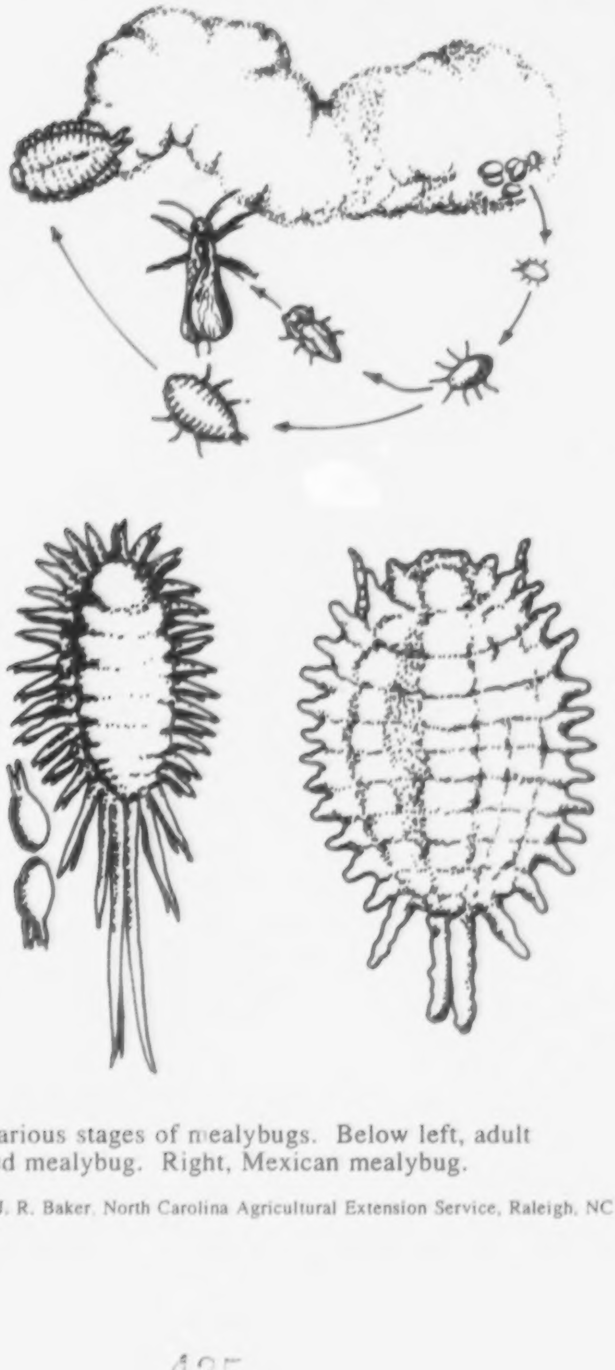
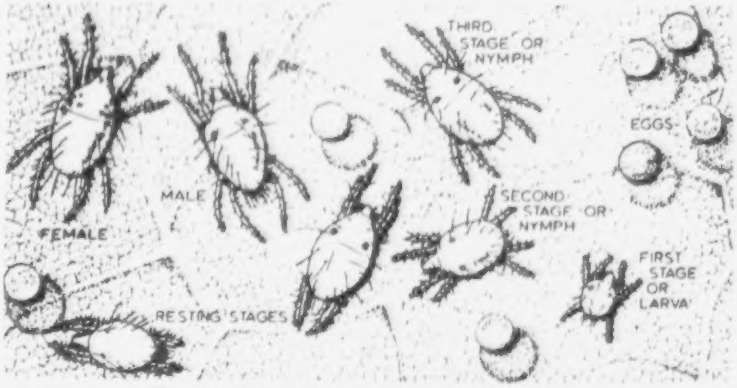
- Fumigants are useful in the control of mealybugs.
- Orthene, Dycarb, Talstar, Dursban, Vapona and Safers Insecticidal Soap are a few of the chemicals that are labeled for use against mealybugs.



Above, various stages of mealybugs. Below left, adult long-tailed mealybug. Right, Mexican mealybug.

Courtesy of J. R. Baker, North Carolina Agricultural Extension Service, Raleigh, NC 27695-7613.

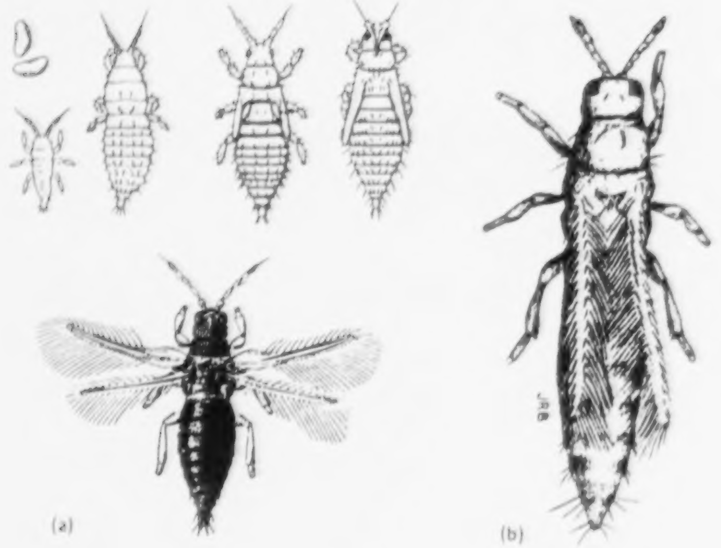
- **Spider mites** are not really insects, they are spiders. However, in greenhouse pest discussions they are included with insect problems.
  - There are many kinds of mites that infest greenhouse plants. The cyclamen mite and the two spotted, or red spider mite as it is sometimes called, are the most common. These mites are very small, 1/50 - 1/100" and difficult to see with the naked eye.
  - Mites are usually found on the undersides of leaves and in flowers. They are even harder to control once they get into the flowers.
  - Their piercing-sucking mouth part pulls the juices from the plant. Injured tissue appears to be covered with tiny yellow speckles; these are the puncture wounds that have dried up.
  - If a mite infestation is severe enough the leaves and flowers will be covered with thin spider webs. These webs prevent the pesticide spray from reaching the mite.
  - Spider mites thrive in hot, dry weather. They will reproduce in ten days if the temperature is 80° F or hotter.
  - Mites reproduce by laying eggs. The eggs hatch into larvae and then nymphs. The nymphs go through three stages of development before becoming an adult.
  - Mites are only affected by pesticides during the adult or nymph stage. This is why they are so difficult to control.
  - Because there are mites in different stages of development on a plant at the same time, pesticides may have to be applied at two to three day intervals until control is achieved.
  - Showering plants with water disrupts the webs and allows the pesticides to make better contact with the pest.



All stages of the two-spotted spider mite.

Courtesy of J. R. Baker, North Carolina Agricultural Extension Service, Raleigh, NC 27695-7613.

- **Thrips** are slender, narrow four winged insects that are usually brown, but can be black or yellow.
    - These insects are not usually visible because they hide deep in the buds and flowers of a plant. To check for thrips shake the flower or bud over a white piece of paper and look for insects crawling on the paper; they usually look like small brown lines moving.
    - Ordinarily, large populations of thrips build up before a grower is aware of the problem. When the population of insects gets large, employees will complain that something is biting them, or making them itch. This is caused by thrips that have gotten on their skin. They will not cause injury to employees but are a nuisance. However, employees can carry thrips to other greenhouses where they will infect the crops there.
    - Thrips have rasping mouth parts; they scratch the plant surface and then lap up the juices that seep out. The damage first appears as silvery or white streaks on the leaves or petals, it later turns to brown streaks as the injured tissue dries up and dies.
    - Thrips are a common insect pest outdoors during the warm months of the year. They are forced in the greenhouse on air currents coming through the ventilation pads.
    - A complete reproduction cycle takes about two weeks. Eggs are deposited in the leaf tissue where they later hatch. The larvae feed on the plant tissue for seven to ten days before changing into adults.
    - Some pesticides that have been effective in controlling thrips are Orthene, Dycarb, Dursban, Vapona, PT 1200 and Dithio.
    - The western flower thrip has developed a resistance to many pesticides.



(a)

(b)

Thrips (greatly enlarged): both species are about 1/16 inch maximum. Left, stages of the greenhouse thrips. Left, an adult flower thrip.

Courtesy of J. R. Baker, North Carolina Agricultural Extension Service, Raleigh, NC 27695-7613.

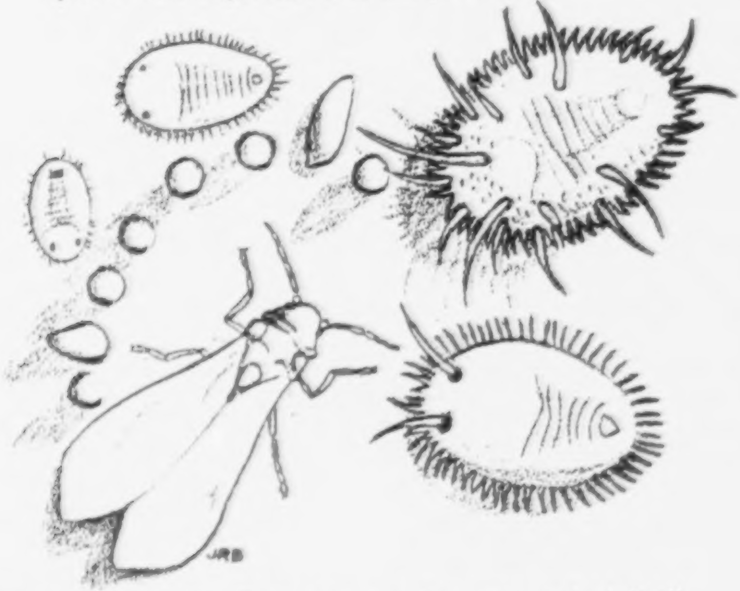
- **Whiteflies** are another common greenhouse pest. As the name implies the insect is a small white insect that is covered with a white powdery wax covering.
  - They are commonly found on the undersides of immature leaves. Insect movement is limited to short flights only when the plant is disturbed. They will usually fly a few inches away from the plant and then settle back on the same leaf.
  - Whiteflies have a piercing-sucking mouth part that sucks plant juices from the host plant. They secrete a honeydew that black sooty mold grows on.
  - Whiteflies will attack numerous crops but they are especially attracted to poinsettias, lantana, tomatoes, fuchsia and salvia.

- The reproduction cycle begins with the female laying eggs in a small circle on the underside of a leaf. When the eggs hatch, crawlers emerge and find a place to feed. They insert their mouth parts and remain in this feeding spot for about three weeks. During that three week period the crawler molts three times and turns into a pupa. The pupa does not feed but develops for seven to ten days and then emerges as an adult.

- These insects are very pesticide tolerant. The adult form of the insect is the only stage that is easy to kill. Because of this a grower must spray every two to three days for 10 to 12 applications to be sure to kill all the whiteflies. If an application is missed, the program must be started over.

- Treatment of whiteflies can be done with Vapona, Talstar, Dibrom, and Thiodan.

- Yellow sticky boards are very effective in the monitoring of whiteflies. They are attracted to the color yellow. Often whiteflies will be transported to another greenhouse on employees if their clothing is yellow. Many greenhouses do not allow employees to wear yellow clothing because of this problem.



The greenhouse whitefly: eggs, numphs, pupa, and adult all found on lower leaf surface.

Courtesy of J. R. Baker, North Carolina Agricultural Extension Service, Raleigh, NC 27695-7613.

- **Rodents** can be a problem in the greenhouse. Rats and mice will eat newly sown seed, freshly stuck cuttings, and the roots of mature plants.
  - Sanitation is a major factor in the control of rodents. Seal up any holes or cracks where rodents can enter the greenhouse.
  - Dispose of debris that serves as a hiding place for these pests. Make sure trash and rotting plant material is discarded; this could be a food source that draws rodents.
  - Baits and poisons have limited success in controlling rodents.

  WARNING: These materials are dangerous to children and other animals and must be used with extreme caution.

  - Traps work well for mice but are less effective on rats.
  - Generally a combination of control measures is required to eliminate a rodent problem.
- Eliminate the pest source when possible. Dead and dying foliage should be removed daily from cuttings on the propagation bench. They only serve as a starting point for a disease or insect pest.
  - Any crop plant that appears to be sick or abnormal should be removed and discarded.
  - Weeds should not be allowed to grow in the greenhouse. This is where insect populations build up and avoid pesticide treatments.
  - The grass and weeds outside the greenhouse should be mowed to a short height. This will limit the number of insects that can be drawn into the greenhouse.
  - Repair any holes in the pads or greenhouse covering that allows free entrance of insects.

- Constantly be on the lookout for problems. A good grower will observe every crop several times a week looking for pest problems.
    - Problems are easier to control if noticed and treated when they first begin. The success rate for treatment is much higher when it is applied early.

OBJECTIVE 2

Distinguish between the types of management techniques for pest problems.

A greenhouse grower can use several methods to deal with pest problems. New nontraditional methods are gaining popularity due to the public's desire for less chemical usage.

- Traditional management techniques for pest control have involved the spraying of synthetic chemicals. These chemicals have been easy to use, relatively inexpensive, and very effective. For these reasons many growers have considered this the only method of controlling pests.
    - A pest problem is identified and a chemical is immediately applied to control the pest. Some growers have routinely sprayed chemicals to prevent pest problems.
    - Negative public image of chemicals has reduced the use of traditional chemical treatments. Few growers spray on a preventive basis today.
    - Some chemicals that have traditionally been used in the greenhouse industry are being removed from the market by the EPA.
    - Organic or natural pesticides are being developed by companies in an attempt to replace the old standard chemicals; Bacillus thuringiensis is a good example.
- Nontraditional management techniques are receiving lots of attention due to environmental issues.
    - Integrated Pest Management (IPM) is a system that tries to keep pest problems below an economically significant level. Traditional control methods try to eliminate pest problems when initially noticed. IPM does not try to control pests until they become severe enough to cause economic damage to the crop.

- A grower has to "scout" the crop and monitor for pests. When the pest population becomes severe enough to cause economic losses a control method is applied.
- IPM also uses other nontraditional management techniques such as resistant varieties and cultural practices.
- When a grower closely scouts a crop, they find pest problems as soon as they begin to develop and can spot treat to stop the infestation.

- Other nontraditional types of pest management are being used.
  - Quarantining of newly arrived plant material prevents the possible inoculation of other crops with insects or diseases. The quarantined crop can be watched to make sure it doesn't have disease or insect problems when it arrives.
  - Spot treatment of pest problems lets the grower treat only infected plants and not the entire crop.
  - Discarding severely infected plants reduces the spread of pests.
  - Natural predators are being tried in greenhouses; however, they have been used with limited success.
  - Organic (nonchemical) sprays are also being tried on greenhouse pest problems.

OBJECTIVE 3

List methods of chemical application.

There are six different ways chemicals can be applied to greenhouse crops. A grower usually has a choice of at least two methods when trying to control a pest problem.

- **Aerosol pesticides** are under pressure in cans. They contain propellants, usually freon or carbon dioxide, that expand when released in the air and carry the pesticide with them. They are basically released like canned hairspray or deodorant. It is an easy way to apply chemicals.
  - Some aerosols are made to spray directly on the plant. Do not get too close to the plant with this spray because it will freeze the tissue. The propellants are very cold when they first come out of the can. This type of chemical is good for spot treating a few problem plants.

- Other aerosols are used to fill the interior of the greenhouse with the insecticide. The amount of chemical needed is based on the square footage in the greenhouse. When the aerosols are released they quickly fill the interior of the greenhouse with the chemical and in a short period of time the chemical settles out and covers the plants.

- Very little of aerosol applied chemicals gets on the undersides of leaves. Unfortunately, this is where many of the pests are, so the kill rate is not very high.

- Temperature is very important in the accuracy of aerosol chemicals. Ideally the temperature should be 70-80° F; above that temperature range plant damage can result and below that temperature range the material does not spread out like it should.

- These materials are harder to use in warm weather because the fans **must** be shut off for several hours until the chemicals settle out. They are usually applied after dark and the fans are left off for the night.

- Examples of aerosols are SBP 1382 and Orthene.

- Warning signs must be placed on all greenhouse entrances to warn people that fumigation is in progress, and not to enter the greenhouse.

- **Drench** is applying chemicals to the growing media. The chemicals are dissolved in water and the solution is poured on the media.

  - A drench solution can be made using liquid, emulsifiable concentrate, dry flowable or wettable powder type chemicals.

  - This method of application is mainly used for pest problems that occur in the growing media; root rot due to pythium or root aphids are good examples.

  - A drench can be applied at any time and is not affected by temperature.

  - This is a time consuming method of application since each pot must individually be drenched.

  - Most fungicides and growth retardants can be applied as a drench. Some insecticides can be applied as a drench to control insects.

- **Fog application** is applying chemicals through fog producing equipment that fills the greenhouse interior with the chemical. This method of application is very similar to aerosol application.

  - Almost any chemical can be mixed with a special carrier that allows the chemical to be turned into a fog.

  - Fogging equipment uses gasoline engines to heat and disperse the chemical solution into tiny particles. These tiny particles are then forced out of the machine in a high velocity air stream. The greenhouse is filled with a chemical fog.

  - Caution must be used with fogging equipment. The exhaust coming out of the machine is very hot and will burn the plants. Fogging equipment should only be used in the greenhouse aisles.

  - Unlike aerosols, chemical fog is visible in the greenhouse. People often report greenhouses on fire when fogging is done because the fog looks like white smoke.

  - Fogging equipment generally requires a large amount of repair and maintenance time.

  - Like aerosol application, fogging must be done when the greenhouse can be closed up. Generally, it is applied several hours after sunset and the greenhouse remains closed all night.

  - Post all greenhouse entrances with signs stating that fumigation is in progress, and not to enter the greenhouse.

- **Granular** application is applying granules of a chemical to the growing media surface. This method of application is used with only a couple of granular insecticides.

  - A specific amount of chemical is sprinkled on the media surface and then the material is watered into the media. The chemical is released from the granule and kills any insects in the media. In addition, the plant absorbs the insecticide and it is transported throughout the entire plant protecting it from any type of insect pest.

  - This type of application is usually done as a preventative measure.
  - The insecticide must be evenly distributed over the media surface and a lot of time is required for application.
  - Oxamyl is a granular type insecticide.

- **Smoke application** consists of burning special formulation chemicals that release the pesticide into the air as smoke. This method of application is much like an aerosol or fog but is easier to apply.
  - The amount of chemical needed is determined by the cubic feet of air space within the greenhouse. Every container states how many cubic feet it will cover and then enough containers are placed in the greenhouse to fill the interior.
  - Containers are spaced along the aisles of the greenhouse and then lit with sparklers. The material in the can burns and the pesticide is released as smoke.
  - As with fogs and aerosols the greenhouse must be shut tight and remain that way until the smoke dissipates, usually overnight.
  - Do not use smoke applications if the temperature is above 85° F or if the plant foliage is wet.
  - Make sure signs are posted on all greenhouse entrances to warn people that fumigation is in progress and not to enter.

- **Spray application** consists of dissolving chemicals in water and spraying the solution on the plant surface. It is the most common method of chemical application.
  - This can be done with hand pumped or electric powered sprayers.
  - Spraying can be done with wettable powder, flowable or emulsifiable concentrate formulations of chemicals.
  - The spray solution must frequently be shaken to keep the chemicals suspended in the solution.

- Surfactants or sticker spreaders may be needed to help the spray solution evenly cover the plant surface. Trition B-1956, Ortho X-77 and Bio-Film are common surfactants.

- Spray particles should be small enough to evenly cover the plant surface. These particles must cover the upper and lower leaf surface.

OBJECTIVE 4

Complete statements about the correct time for chemical application.

Proper application of a chemical means putting the material on when it will be most effective. Growth retardants applied when a plant is six inches too tall will have no effect on reducing the plant's height.

- Some crops receive a fungicide drench as a preventative treatment.

  NOTE: Traditionally fungicides have been applied at transplanting or on a 30 days basis. However, with proper cultivation practices and attention, this practice may not be necessary.

  - Diseased plants cannot be brought back to a healthy condition. If a geranium stem has pythium rot it will not disappear with a treatment of fungicide; the fungicide will stop the spread of the disease to other plants but it will not heal infected plants.

- Growth retardants should be applied when the plants are very small. For example, seed geraniums are usually treated when they are the size of a quarter.

  - These chemicals reduce cell elongation but not cell division. If the material is applied too late many of the cells will have already elongated and the plant will be too tall at the end of the production phase.

- Insecticides should be applied when the insect pest is most vulnerable and at a significant population level. The discussion on pest identification covered the stages of development when pests are most susceptible to chemical treatment.
  - Insecticides often have to be reapplied at a critical time. If an insect reproduces every three days, the chemical will have to be applied every two days for several applications if all the insects are to be killed. Treating plants once a week will never control the pest population because they are reproducing faster that the chemical is being applied.
  - If one chemical application is missed in a treatment series, the whole series must be started over again.
- Early detection is the key to successful control of any cultural problem. It is much easier to correct a small problem on a few plants than a major problem on an entire crop.
  - Cro[illegible]uld be thoroughly scouted at least once a week for any [illegible]t, disease or cultural problems.
- Discard severely infected plants. Throwing away a few plants could save the rest of the crop.
  - Growers may try to save a small number of contaminated plants; they might have a fungal disease or be severely infested with insects. These sick plants only serve as breeding ground for the pathogen which will infect other plants.

OBJECTIVE 5

Select from a list true statements about identifying chemical injury to plants.

Sometimes chemicals can injure plant tissue. The plant may be sensitive to that specific chemical, the chemical might not have been mixed correctly or was applied too heavily or at the wrong time of day.

- Spot treat a few plants the first time a chemical is being used. Apply the chemical to eight or ten plants and wait at least five days to see what happens.
  - These tests should be done on each crop to see if that crop is sensitive to the chemical. If several cultivars are being grown, test each cultivar.
  - If a spot test produces plant injury, try applying the chemical in the late evening or after dark. Sunlight often causes the chemical to damage plants.
- Typical symptoms of chemical injury on plants is burnt foliage.
  - This damage may appear as tiny dark spots randomly scattered over the entire leaf surface, or as large areas of dark tissue usually near the leaf margins.
  - Some plants show chemical injury by dropping large numbers of leaves. The leaves may remain green and simply fall off, or they may turn yellow and then drop off.
  - Open flowers and colored bracts are very sensitive to many chemicals, especially if they are sprayed on. Injury symptoms will be dark spots or holes in the petals.
  - Fumigant type chemicals seem to cause less injury to flowers and bracts than spray types.
- Minimize chemical injury by being sensible when applying chemicals.
  - Make sure the growing media is wet and the plants are not in a water stressed condition when the chemicals are applied.
  - Do not apply chemicals during the hottest part of the day. The spray solution can dry very quickly and leave a concentrated chemical residue on the leaf surface.
  - Do not use aerosols, smokes or fogs on plants that have wet foliage. These wet areas will collect the chemical at high rates and tissue damage will occur.

- Avoid over application of chemicals. Most chemicals require the applicator to lightly, but completely cover the foliage with a mist. Many applicators will douse a plant until the chemical is running off the leaf margins. This can definitely cause phytotoxic effects on the plant, and wastes chemical.

- The chemical label will tell the grower what plants will not tolerate the chemical.

ASSIGNMENT SHEET 1

IDENTIFYING AND CONTROLLING PESTS IN THE GREENHOUSE

VIII

NAME ______________________________ SCORE ________

OBJECTIVE 6 - **Develop a chemical shopping list.**

INTRODUCTION

Objective 1 covers the major greenhouse pathogens and insect pests. Every greenhouse will have these problems at one time or another. This objective lists a few of the chemicals that will help control the disease and insect problems.

DIRECTIONS

You have decided to build your own greenhouse and must purchase a supply of chemicals. The amount of money you can spend for all chemicals is $500. Since the budget is so tight you have decided that you can only afford to buy three insecticides and three fungicides.

Go through the information on pests and their recommended chemicals and select the three most useful insecticides and fungicides. Each of these chemicals should control several different pests so you will be able to rotate chemicals but still get control of many pests. Once you have selected your chemicals, list them on a separate sheet of paper and give the size and price of each material. Use the A.H. Hummert catalog for sizes and prices. Also, give the total cost of all chemicals.

IDENTIFYING AND CONTROLLING PESTS IN THE GREENHOUSE

ASSIGNMENT SHEET 1

Use the following criteria for evaluation:

- The chemicals selected should have a broad spectrum of kill so they will get the most for their money.
- They must stay within the $500 limit.
- Their list should be legible and they must state the size and price of each chemical.

OBJECTIVE 1

Select from a list true statements about the pest problems. Write an "X" in the blank before each true statement.

____ 1. Fungal diseases are common in greenhouses due to the warm, humid conditions.

____ 2. Powdery mildew causes black slimy lesions on plant stems.

____ 3. Damping off causes seedlings to fall over at the media line.

____ 4. Aphids are small insects with bodies covered with a white waxy material.

____ 5. Aphids are usually wingless, but if food is in short supply they will develop wings and fly to a new spot and start a new colony.

____ 6. Aphids have chewing mouthparts.

____ 7. Mealybugs are usually found in the axils of leaves or on newly expanding tissue.

____ 8. Mealybugs reproduce every three days.

____ 9. Spider mites are really spiders and not insects.

____ 10. Spider mites are found on the underside of plant leaves.

____ 11. Spider mites have piercing-sucking mouth parts and damage appears as yellow specks on the plant.

____ 12. Spider mites do not form spider webs.

____ 13. Thrips have rasping mouthparts.

____ 14. Thrips will bite greenhouse employees and cause measles if they are present in large numbers.

____ 15. Whiteflies only fly when the plant they are on is moved or disturbed.

____ 16. Poinsettias and lantana are prone to get whiteflies.

____ 17. Whiteflies are very attracted to the color red.

____ 18. Dead or dying plants should be discarded because they harbor insects and disease.

____ 19. Very few insects come into a greenhouse from the outdoors.

OBJECTIVE 2 **Distinguish between the types of management techniques for pest problems.** Write a "T" in front of the techniques that are traditional management procedures and an "N" in front of the nontraditional management techniques.

____ 1. Spraying Ivory soap solution

____ 2. Spot sprays

____ 3. Spraying with Sevin

____ 4. Weekly sprays of Diazinon

____ 5. Quarantine

____ 6. Using ladybugs to control aphids

____ 7. Integrated pest management

____ 8. Fumigation every 5th day

OBJECTIVE 3 **List methods of chemical application.**

OBJECTIVE 4 **Complete statements about the correct time for chemical application.** Write the missing word in each blank.

1. Growth retardants should be applied when the plants are very ____________________ .
2. Growth retardants inhibit cell ____________________ .
3. Insecticides should be applied when the pest is most ____________________ .
4. To detect early pest problems a crop should be ______________ once a week.
5. A severely infested plant should be ____________________ .

OBJECTIVE 5

Select from a list true statements about identifying chemical injury to plants. Write an "X" in the blank before each true statement.

____ 1. Excessive chemical application can cause plant damage.

____ 2. Spot treating a plant for pesticide sensitivity means spraying only one leaf on a plant and waiting to see what happens.

____ 3. Fumigation type chemicals cause more plant injury than sprays.

____ 4. Chemical injury usually appears as burnt foliage.

____ 5. Flowers and bracts are not very sensitive to chemicals.

____ 6. Applying chemicals during the hottest part of the day may cause plant injury.

____ 7. A chemical label tells what plants will be injured by the chemical.

NOTICE

The following assignment sheet is not part of the written test. If this activity has not been completed, check with your instructor.

OBJECTIVE 6

Develop a chemical shopping list. SCORE ________

WRITTEN TEST ANSWERS
IDENTIFYING AND CONTROLLING PESTS IN THE GREENHOUSE
VIII

OBJECTIVE 1

1, 3, 5, 7, 9, 10, 11, 13, 15, 16, 18

OBJECTIVE 2

1. N
2. N
3. T
4. T
5. N
6. N
7. N
8. T

OBJECTIVE 3

- Aerosol
- Drench
- Fog
- Granular
- Smoke
- Spray

OBJECTIVE 4

1. small
2. elongation
3. vulnerable
4. scouted or checked
5. discarded

OBJECTIVE 5

1, 4, 6, 7

OBJECTIVE 6

Refer to answers to Assignment Sheet 1.

OBJECTIVE SHEET

MARKETING GREENHOUSE PRODUCTS

IX

INTRODUCTION

Most greenhouse growers concentrate on the production of high quality crops. Having high quality crops is important, but just as important is having a marketing strategy to sell those crops. A solid marketing plan must be developed and followed if the greenhouse is to be a successful business.

UNIT OBJECTIVE

After completing this unit, the student should be able to develop and carry out a marketing strategy for a greenhouse. The student will demonstrate these competencies by completing the assignment sheets, job sheets and written test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Select from a list true statements concerning marketing territory.
2. List potential buyers.
3. Discuss customer's needs.
4. Complete statements about available sales options.
5. List factors that should be included in a marketing strategy.
6. List examples of promotional aids and public relations.
7. Select from a list true statements about factors that contribute to a good advertisement.
8. List methods of advertising.
9. Discuss maintaining a customer list.
10. Discuss production cost and selling price.
11. Create a newspaper advertisement for a greenhouse. (Assignment Sheet 1)
12. Determine the production cost and establish a selling price. (Assignment Sheet 2)

PREPARATION

- Obtain materials to supplement unit.

  NOTE: See Suggested Resources.

- Review instructional outline for this unit. Modify time frames to suit class needs and plan activities for each class period.
- Study the specific objectives to determine those you will cover in your presentation. Decide also which objectives should be taught to which students.
- Determine scope and sequence of objectives that you add. Design and develop support materials, including evaluation techniques, for additional objectives.
- Determine how you will schedule time for students to demonstrate competence in the required procedures.
- Make arrangements for guest speakers. Supply speakers with specific objectives and other appropriate sections of the unit.

DELIVERY

Objective 1

- Introduce the topic of marketing greenhouse products. Ask students how they think marketing greenhouse products differs from marketing other products.
- Discuss marketing territory.
- Have a commercial greenhouse operator discuss marketing strategies with the class.

Objectives 2 through 4

- Discuss identifying potential buyers.
- Discuss customers' needs. Ask students what they as consumers would want from a greenhouse.
- Discuss available sales options.

Objective 5

- Discuss factors that should be included in a marketing strategy.

- Bring in catalogs from major horticulture companies and have students discuss what they think are those companies' marketing strategies.

Objective 6

- Discuss promotional aids and public relations.

- Have students bring examples of promotional aids such as pens, calenders, etc. to class.

- Bring an example of a public relations news story to class. An example would be a story about an open house at a local greenhouse.

Objective 7

- Discuss factors that contribute to a good advertisement. Ask students what makes them buy a product.

- Have students bring in copies of advertisements and discuss whether they think the advertisements are good or bad.

Objective 8

- Discuss methods of advertising.

- Find out the costs of the different methods of advertising in your area and bring them to class.

- Bring examples of newspaper ads, direct mailing, and telephone yellow page ads to class.

Objective 9

- Discuss maintaining a customer list.

Objective 10

- Discuss calculating production cost and selling price.

APPLICATION

Objective 11

- Use Assignment Sheet 1 to teach students how to design a newspaper advertisement.

Objective 12

- Use Assignment Sheet 2 to teach students how to determine production cost and selling prices.

EVALUATION

Written Test

- Explain to students that they will be asked to demonstrate on the written test actions listed in the specific objectives.
- Give written test.

  NOTE: Written test may be given in sections if desired.
- Evaluate students on assignment sheet activities if not previously done.
- Reteach and retest if necessary.
- Complete appropriate section of competency profiles.
- Review individual and group performances in order to evaluate teaching methods. Adjust scope, sequence, or instructional approaches for additional lessons as required.

SUGGESTED RESOURCES

Learning Activity Packets

- MB4 Marketing Strategies. Order No. DE 3084.
- MB1 What/Why of Marketing. Order No. DE 3021.
- MB2 Marketing Functions. Order No. DE 3022.

NOTE: The above materials are available from the Curriculum and Instructional Materials Center, Oklahoma Department of Vocational and Technical Education, 1500 West Seventh Avenue, Stillwater, OK 74074, phone 1-800-522-5810, ext. 589..

UNIT REFERENCES

- Berninger, Louis, *Profitable Garden Center Management*, 2nd. ed. Reston Publishing Company, Inc., Reston, Virginia, 1982.
- Mastalerz, J.W. and E. Jay Holcomb, *Bedding Plants III*, Pennsylvania Flower Growers, 1985.
- Nelson, Paul V., *Greenhouse Operation and Management*, 3rd. ed. Reston Publishing Company, Inc., Reston, Virginia, 1985.

BASIC ACADEMIC SKILLS

The following table identifies the basic academic skills that are reinforced in this unit of instruction. These basic academic skills were identified using *The Basic/Essential Skills Taxonomy*, 2nd edition, and verified during the validation process.

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 1	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity
	Free Enterprise 118	Identifies	Cost factors	
OBJECTIVE 2	Language Arts 132	Comprehends	Information-written	
	Language Arts 038	Collects/ Organizes	Information-oral/written	
	Free Enterprise 069	Describes/ Explains	Economic concepts	Marketing
OBJECTIVE 3	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
	Language Arts 098	Composes/ Edits	Reports/ essays	Summaries
	Free Enterprise 115	Describes/ Explains	Needs/wants	Goods/ services
	Free Enterprise 050	Defines	Economic terms	Retail
	Free Enterprise 061	Describes/ Explains	Business cycles	

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 4	Free Enterprise 041	Defines	Economic terms	Price
	Free Enterprise 016	Defines	Economic terms	Credit
	Free Enterprise 053	Defines	Economic terms	Services
	Free Enterprise 082	Describes/ Explains	Financing	Credit-consumer
OBJECTIVE 5	Free Enterprise 069	Describes/ Explains	Economic concepts	Marketing
	Free Enterprise 118	Identifies	Cost factors	
OBJECTIVE 6	Language Arts 132	Comprehends	Information-written	
	Language Arts 038	Collects/ Organizes	Information-oral/written	
OBJECTIVE 7	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity
OBJECTIVE 8	Language Arts 132	Comprehends	Information-written	
	Language Arts 038	Collects/ Organizes	Information-oral/written	
	Free Enterprise 119	Identifies	Cost factors	Advertising

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 9	Language Arts 132	Comprehends	Information-written	
	Language Arts 038	Collects/ Organizes	Information-oral/written	
	Language Arts 098	Composes/ Edits	Reports/ essays	Summaries
OBJECTIVE 10	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
	Language Arts 013	Applies/Uses	Definitions	
	Mathematics 174	Interprets	Charts/tables/ graphs	
OBJECTIVE 11	Language Arts 035	Attends	Directions/ task	
	Language Arts 094	Composes/ Edits	Reports/ essays	Persuasive text
	Language Arts 049	Composes/ Edits	Audio-visual aids	

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 12	Mathematics 261	Uses calculator	Addition	
	Mathematics 262	Uses calculator	Division	
	Mathematics 266	Uses calculator	Multiplication	
	Mathematics 268	Uses calculator	Subtraction	
	Mathematics 015	Calculates/ Evaluates	Percent	In/decrease, markup/ discount
	Language Arts 013	Applies/Uses	Definitions	

MARKETING GREENHOUSE PRODUCTS IX

OBJECTIVE 1

Select from a list true statements concerning marketing territory.

Marketing greenhouse crops means finding, or creating, a demand for your product in the marketplace. Once the demand has been developed the potential buyers must be willing to pay a fair price for the product.

- Distance is a major factor to consider when planning a marketing territory.
  - Most greenhouses use truck routes to sell to customers that are less than a day's drive away; 150-200 mile radius. Employees are home every evening and trucks can be reloaded for the next day's sales.
  - Greenhouses usually run a different truck route every day. For example, Monday is the north route, Tuesday is the east route, Wednesday is the west route, Thursday is the south route, and Fridays are used for truck maintenance and repairs.
  - Long distance shipments, 500 miles or more are not economical unless large orders are delivered to several customers in nearby locations.
- Accessibility is a factor to consider when planning the marketing area. Are the roads well maintained and safe? Will the anticipated sales from the area justify the wear and tear on the delivery vehicle?
- Number of customers located in an area should be considered when determining the marketing area. A greenhouse operator must seriously consider if one customer located 80 miles away is worth the drive. Maybe your products could be sent to them by an alternate method such as next day mail or next day UPS delivery.
- Volume of products delivered to customers in an area must also be considered. Maybe deliveries on certain routes are economically feasible only if the truck goes every other week.

- Future expansion of sales in an area should also be considered. If an area is rapidly growing it has a high potential for increased sales in the future. Including that area in delivery routes will familiarize customers with your company's name and product quality.

- Competition will probably exist for these buyers. To gain buyers, your product must be different or of higher quality than your competitor's product. Evaluate the number of competitors in the area.

OBJECTIVE 2 **List potential buyers.** (Activity Sheet 1)

To successfully market greenhouse crops a grower should know exactly who their customers are. Is your greenhouse planning on selling to retail outlets, mass markets, directly to the consumer, or a combination of all outlets? You should also be aware of future changes in that market.

- **Mass market outlets** are large stores that offer limited services and specialize in low prices. These outlets purchase large amounts of greenhouse products. Does your intended marketing area contain discount stores, large supermarkets or any other mass market outlet? Would these stores be interested in your products?

- **Retail nurseries and garden centers** may not be able to grow enough greenhouse products to satisfy their needs so they purchase finished crops from other growers. These customers are usually consistent buyers on a year-round basis. How many of these outlets are in your marketing area and what percentage of them are potential customers?

- **Florist shops** generally purchase foliage and blooming pot plants on a year-round basis and seasonal crops for holiday sales. These customers do not buy large amounts of plants but they will purchase regularly each week. What proportion of your market do these customers make up?

- **Retail consumers** are the biggest potential buyer for a greenhouse. Is your greenhouse interested in selling directly to the consumer? If so, make sure your marketing area has the buyers to support a retail business. The following questions should be asked:

  - What is the economic condition of your marketing area? Is it experiencing an economic recession or is the economy growing? Are there anticipated job layoffs at major employers in the area?

  - Is the population of the marketing area increasing or decreasing? A retail business located in a town that is losing population does not have much chance for growth in the next few years.

  - What is the average income of the consumer? Do they have money to spend on greenhouse crops?

  - What is the average age of the consumer in your marketing area? Are these people interested in gardening and greenhouse products?

  - Evaluate all these factors and then decide who your major buyers will be.

OBJECTIVE 3

Discuss customers' needs.

A greenhouse grower must produce crops that will be appealing and desirable to the predicted buyers. Successful greenhouses survive by satisfying customers with the products and services they desire. The type of customer has a large effect on the type of product grown.

- Mass market outlets generally want small sized products that are inexpensive. These businesses expect to receive the plants and sell them within a few days. They usually use bedding plants as leader items to get consumers to purchase other garden supplies.

  - They generally increase the price of the product 10-20% over what they paid the grower. Sometimes they sell the products at cost to draw customers.

  - They prefer cell packs over individual pots and usually want 8 or 10 inch hanging baskets.

  - Very seldom will they request specific cultivars or crops.

  - Cost is a major consideration.

- Retail nurseries and garden centers are more interested in quality but they are still very price conscious.

  - They prefer larger sized hanging baskets, 10 inch or larger.

  - Larger sized cell packs are in demand as well as small individual pots.

  - They expect quality in the products they purchase and are very concerned about how the plant will perform for the consumer.

  - Specific species and cultivars are requested, and they may not accept any substituted cultivars.

- Florist shops demand the highest quality. Their products sell for higher prices so they must have large, top quality plants.

  - They usually do not request specific cultivars, but they will have a preference of colors.

  - Many growers grow seasonal crops especially for florists because they prefer larger plants than other customers.

- Desires of retail consumers are the most difficult to predict. The plants and colors preferred by consumers change from year to year.

  - The size of plants needed for retail consumers are very diverse. Cell packs are the most popular size of bedding plants with four inch pots gaining in sales. A few consumers want bedding plants in six inch pots.

  - Hanging baskets will mainly be produced in 10 inch baskets. A small number of larger baskets, and sphagnum moss wire baskets are also required.

  - Perennials in three and four inch pots are becoming big sellers in the retail market.

  - Herbs have been increasing in volume of sales and vegetables have been showing a slight decrease.

- Geographical location has a large effect on what crops a customer will want. Cool season crops are very popular in the northern United States but are not popular in the southwest. Realize what crops perform well in your area and produce crops that are adapted to that climate.

- Horticultural supplies are desired by retail consumers. People who buy plants at a greenhouse expect to find chemicals, fertilizers and other required materials at the greenhouse. Knowledgeable sales personnel should be available to assist customers.

OBJECTIVE 4

Complete statements about available sales options.

A grower has several options on how greenhouse products are sold. Ideally the grower should choose a method that is acceptable to the customer and profitable for the seller.

Types of Customers

- Wholesale prices are usually given to landscapers and commercial customers. A wholesale price is lower, usually 20% or more, than the normal retail sales price.
    - These buyers are given this special price as an incentive to continue buying plants from your business.
    - A grower can afford to sell at lower prices because these customers buy large quantities of plants at one time and they do not need cultural information or assistance. Many landscapers come to the greenhouses and pick up their own plants.
- Retail sales options are used when the general public comes to the greenhouse to purchase plants. The price they pay is higher than what a wholesale customer pays.
    - These customers require sales personnel to answer questions and help make plant selections.

Methods of Purchasing

- Cash sales are sometimes required for new commercial customers. They are charged the wholesale price but they must pay the account balance when the plants are received.
    - Cash will be required from new commercial accounts until the grower becomes familiar with the customer and gains information on the business's credit history. Any customer who has a bad credit history will be required to pay cash for all sales.
- Credit sales do not require the customer to pay for the product when it is delivered. These are reliable customers who have purchased from your greenhouse before and have a good credit record. You trust them for the money they owe your greenhouse.
    - Most credit sales are 30 day net; the account balance must be paid in full in 30 days or interest will be charged on the amount due. Most greenhouses have at least a 10% finance charge.

  - A credit customer may be charged the wholesale or retail price.
  - Extra time and labor is required to keep track of credit accounts and to send out invoices.
  - Credit sales are a special service your business offers to customers. You want to keep these customers so you do special things to help them out.
  - Poor accounts receivable management is the cause of many greenhouse failures.

- Credit cards and checks may or may not be accepted by a greenhouse.
  - Credit cards require additional bookkeeping and a fee is charged when the claim is filed.
  - Checks are troublesome when there are insufficient funds in the account. Many times a bad check will have to be written off as a loss because it is not worth what it would cost to press legal charges against the customer.
  - Credit cards and checks are a common method of payment and sales will be lost if these methods are not accepted. It is up to the greenhouse management to decide if the business wants to accept these methods of payment.

OBJECTIVE 5

List factors that should be included in a marketing strategy. (Activity Sheet 2)

After the greenhouse management has considered all the possible marketing and selling options available to the business, a plan of operation must be developed and followed.

A marketing strategy is a written plan telling how the business will operate. This plan can be modified and updated. There will probably be mistakes to be corrected and new ideas to be implemented.

Without a plan the business has no goals or direction and it cannot grow and profit. Factors that should be included in the marketing strategy are:

- **Intended customers**

  EXAMPLE: Our greenhouse is going to mainly sell to commercial nurseries, garden centers and mass market outlets; in two years we plan to open a retail outlet.

- **Marketing area**

  EXAMPLE: A truck will deliver plants to businesses within a 200 mile radius of the greenhouse. Deliveries will be made Tuesday through Friday. Delivery will be free of charge if the customer orders $100 or more; if the order is less than that there will be a $10 delivery charge.

- **Sales procedure**

  EXAMPLE: Will be cash/ check for orders less than $100 and credit sales will be given on orders over $100. The account balance is due 30 days after the sale or a 15% finance charge will be accessed. Any retail customers who come to the greenhouse will be charged 50% more than a wholesale customer.

- **Operating hours**

  EXAMPLE: The greenhouse will operate from 7:30 a.m. to 6:00 p.m. Monday through Saturday and will be closed on Sundays. Delivery trucks will be loaded with plants the night before delivery and will leave the greenhouse at 7:00 a.m.

- **Advertising**

  EXAMPLE: The advertising budget will mainly consist of direct mailings and radio commercials.

OBJECTIVE 6 **List examples of promotional aids and public relations.**

Promotional aids are anything which will enhance the image of your business and help customers remember your products.

The following suggestions are good ways to promote a business:

- Your business should be neat and clean. No customer wants to go into a run-down facility with weeds and trash lying around.

- Have a professional sign outside your business so customers will know where you are located.

- All employees should wear uniforms that are neat and clean. A uniform can be as simple as a tee-shirt with the company name printed on it or as sophisticated as a button shirt and trousers.

- Delivery vehicles should be clean and should have the greenhouse's name professionally painted on the outside. Customers equate plant quality with the appearance of the employees and the facility.

- Display areas should be clean and well stocked. No one will buy plants from your business if the display shelves contain dead and dying plants.

- Attractive stationery and professional quality direct mail ads and invoices should be used. This lets the customer know that your business takes pride in neatness and quality.

- All sales personnel and employees should be polite, courteous and friendly toward the customers.

- Advertising should be done with the help of a professional agency. They are trained to create attractive and effective ads.

- Giving away items like ink pens, rulers or magnets with your business's name is a good promotional tactic.

Public relations is a good form of advertising. Any type of display or public recognition gains support for your business in the community.

The following are some suggestions for public relations:

- Writing a gardening column in your local newspaper once a week.

- Providing gardening tips on a radio station.

- Offering gardening tips on a telephone recording.

- Providing plants for special community functions.

- Writing news releases for events at your business.

OBJECTIVE 7

Select from a list true statements about factors that contribute to a good advertisement.

The goal of any method of advertising is to attract new customers who will purchase your product. Successful advertising requires planning and a monetary investment.

- Hire professional advertisers to help develop an effective and professional ad to increase sales at the greenhouse.
  - Professional advertisers can be hired on an hourly basis to work with small businesses.
  - Consumers are bombarded with advertisements. A poorly designed ad will have no effect on the consumer and will not increase sales at the greenhouse.
  - Professional advertising companies are expensive but are well worth the money. Advertising should be considered a necessary expense just as employee wages or heat for the greenhouse.
- Time the advertisements to coincide with holidays or periods when people need your product. For example, insecticides will not sell well in January even with a professionally designed newspaper ad; however, in July the advertisement will most likely be a big success.
- Use repetition in your advertising campaign. The more consumers see or hear your ad the more they will remember it.
- Make sure advertisements convey an accurate message to the consumer.
  - Use the three basic goals in your advertisements:
    1. Attract the attention of the consumer.
    2. Inform them about your product.
    3. Convince them to purchase your product.
  - Present the strong points of your business in the ad. Tell the reader or listeners that your products are very high in quality or that you have a new product not available at any other greenhouse.

  - Be sure to list important information that the consumer needs to know such as the name and location of the business. You may also want to include your phone number and operating hours.

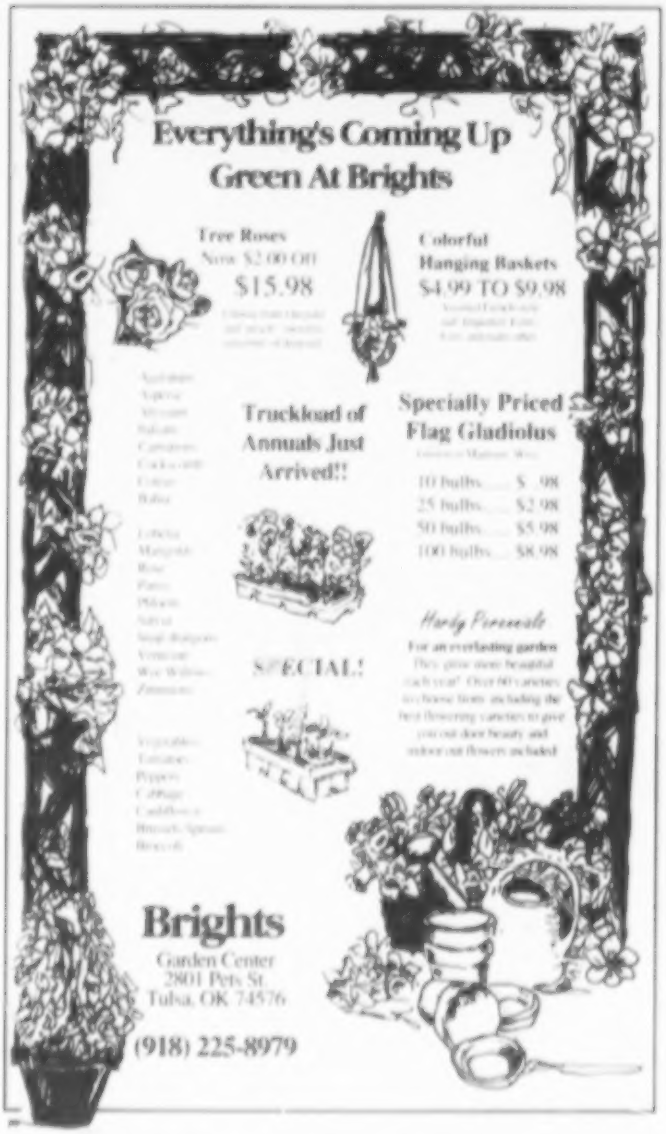
- Make the ad easy to read or listen to. Do not fill every inch of newspaper space. Open space attracts readers and makes the ad easier to read.

Serious About Your Garden?

Whether you're a serious gardener or just like to play in the dirt, Bloom's Garden Center has everything you'll need. We have a great selection of vegetables from our greenhouse and everything for your lawn. If it's garden tools you need — we can put a handle on it !!

Bloom's Garden Center
715 Iris Avenue
Yourtown, Yourstate
(000)000-0000

- Written advertisements or radio messages that are packed full of "stuff" turn a consumer off; they get lost in the jumble of words, or tune your message out.



Everything's Coming Up Green At Brights

Tree Roses
Now $2.00 Off
$15.98

Colorful Hanging Baskets
$4.99 TO $9.98

Truckload of Annuals Just Arrived!!

Specially Priced Flag Gladiolus

10 bulbs.....	$ .98
25 bulbs.....	$2.98
50 bulbs.....	$5.98
100 bulbs.....	$8.98

Hardy Perennials

For an everlasting garden

SPECIAL!

Brights
Garden Center
2801 Pets St.
Tulsa, OK 74576

(918) 225-8979

- Use artwork to catch the reader's eye. If relevant artwork can easily be incorporated into an advertisement more consumers will notice the ad. Artwork should be included in print ads.

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- Budget for advertising at the beginning of the fiscal year. Money is budgeted for labor, media and water; advertising should be treated as any other necessary expense.
  - Some growers allot a percentage of last year's sales for advertising; 5% of the gross sales is a common amount. This method does not account for increases in sales or expansion of the business. It is a conservative method of estimating the amount of advertising needed.
  - Other growers allot a percentage of this year's expected sales. This plan accounts for projected increases in growth at the greenhouse. By allowing more money for advertisements the greenhouse will probably draw more customers and sell more plants. The grower uses the estimated sales dollars to pay for the ads, but if sales turn out to be less than estimated the advertising budget may be overspent.

OBJECTIVE 8

List methods of advertising.

There are different methods of advertising. A business should evaluate the methods and select the ones that best fit their needs. Factors such as cost, and what potential buyers are to be reached, will affect which media is selected.

- **Television** is generally a more expensive form of advertising; however, greater customer response is usually returned. Although television ads reach many consumers a good number of them will not be interested in your product. Advertising on local television channels may be feasible for some businesses.
- **Radio** is usually less expensive and more convenient to use. A greenhouse may not want to buy advertising time on a rock and roll station, but an easy listening or community AM station would be more likely to have listeners who are interested in greenhouse products.
  - Drive time, the time when most people are driving to or from work, is the prime period when a captive audience can be reached.
  - Radio spots during the noon hour will reach a large listening audience.
  - Radio ads must create a mental picture of your product in the listener's mind.
  - Research your audience and radio stations.

- **Local newspaper** ads are relatively inexpensive and are the most commonly used form of advertising. These ads provide the reader with something they can tear out and use as a reminder of your sale.
  - Weekly newspapers in small towns have a high readership, and these people are very supportive of home town businesses.
  - Use several four inch ads in a newspaper rather than one quarter page ad. Remember, repetition helps the message to stick in the consumer's mind.
  - Ads should be run at the end of the week since most gardening products are sold on the weekend.
- **Direct mailing** sends advertisements to consumers through the postal service. They are very client specific and are an accurate form of advertising if the mailing list is up-to-date and correct.
  - A mailing list which is out-of-date or which contains people who are not interested in your product is very inefficient and expensive.
  - As postage increases the cost of direct mailing increases.
- **Telephone yellow pages** are useful advertising tools, but are often expensive. Many people use the yellow pages when seeking information about a specific type of business.
- **Point of purchase displays** are items that are displayed at your business to attract customers. Attractive window displays and flower beds in front of the greenhouse will attract customers who drive or walk by.

OBJECTIVE 9

Discuss maintaining a customer list.

A customer list can be a valuable source of information to a new or expanding business. Often the value of a greenhouse business is increased due to a customer list.

- **Why is a customer list needed?** Most businesses like to give valued customers special offers from time to time. This bonus rewards customers for being loyal to your greenhouse and makes them feel special.
  - Customer lists are essential if the greenhouse wants to conduct direct mail advertising.

- If the greenhouse business is ever going to be sold, a good customer list will be valuable to potential buyers and will increase the worth of the business.

- **How do you develop a customer list?** Customers can fill out a mailing list form and office personnel can manually file the data or put it into a computerized mailing list program.

  - Names and addresses can be collected from checks that are written at your business. This method can be used to compile a selective list of customers, people who spend at least $20.00 for example.

  - Door prize drawings are a good way to start a customer list. Most people will fill out a slip of paper to win a free prize.

  - Garden club members from your local community would be likely customers at a greenhouse.

- **What information should be included on the list?** For retail customers all that is needed is a name, address and maybe a phone number. This is all the information that is needed for direct mail advertising.

  - Commercial accounts require more information.

  - You should have the name, address and telephone number of the business.

  - Include the name of the person you will be dealing with. If you are calling about a sales order you should know the name of the manager or assistant manager since they make the decisions on what will be purchased.

  - If there is a problem with their account payment you will need to know the bookkeeper's name.

  - Knowing people on a first name basis makes them feel like you are interested in them and don't just consider them as another customer.

  - Some growers prefer to make notes on each account and keep a file on that person or business. This is time consuming but it can be very useful. You can quickly remind the person how many poinsettias they bought from you last year, or how well the 6" geraniums sold last spring.

- **When should the customer list be edited?** Most businesses edit the customer list twice a year. This is usually done immediately after a major sales periods - January and July.
    - The list should be edited at least once a year to remove the names of customers who no longer shop at your business.
    - New customers, especially wholesale, should be added to the customer list as soon as they purchase from your greenhouse.
- **How should a customer list be maintained?** Customer lists can quickly become very large.
    - Hand kept records are usable but very inefficient. An employee must address envelopes by hand every time something is mailed to a customer.
    - Computers are excellent for maintaining mailing lists. They quickly print address labels for envelopes and allow your employees to prepare large numbers of advertisements efficiently.
    - Any type of data base software program with mail merge capacity can be used to compile a customer list.
    - Computerized customer lists are very efficient at creating special lists such as florist shops your greenhouse sells to or retail customers in your home town. A computer quickly prints out the requested list while it would take an office employee several hours to go through the customer list and write the names for special lists.

OBJECTIVE 10

Discuss production cost and selling price.

- Many growers do not know how much it actually costs them to produce a crop. They grow the crop and then wait to see what the greenhouse down the road is selling the same plant for and charge that price. This "**follow the leader**" attitude has caused many small sized greenhouses to lose valuable profits.
- Know what it costs you to produce a plant. Once this figure is determined you can then make a reasonable profit on the plant.

- Determine how much it costs to operate your greenhouse. For the first several years keep track of all expenses for the entire year; water, heat, electricity, media, chemicals, labor and **all** other bills.
  - At the end of the year divide the total expenses by 52 weeks/year and this will tell you how much it costs to operate the greenhouse per week.
  - Take that number and divide it by the total square footage of bench space in the greenhouse. This will tell you how much it cost a week for each square foot of bench space.
  - For example a greenhouse is 50'x100' and has 3500 square feet of bench space. The expenses to operate the greenhouse for a year were $43,295. It cost $0.24/sfw (square feet week) to operate the greenhouse.

$$\frac{\$43{,}295/\text{yr}}{52\ \text{wks./yr}} = \$832.60/\text{wk}$$

$$\frac{\$832.60/\text{wk}}{3500\ \text{sq ft}} = \$0.24/\text{sfw}$$

  - Until you have been able to determine the cost/sfw for your greenhouse use $0.30 as an estimating figure.
- Calculate how many sfw the crop required during production and then an accurate production cost can be calculated.
  - Unit 6 objective 3 discusses how to calculate the sfw for a crop.
- Calculate total production cost by using the following formula.

$$(\text{sfw it took to produce the plant})(\text{cost/sfw}) + \text{plant cost} = A$$

$$\frac{A}{100\% - \%\ \text{crop loss}} = \text{total production cost}$$

  - An example calculation for 4 1/2" geraniums grown at a 6"x6" spacing for 7 weeks and cutting cost 12 cents and a 6% crop loss.

$$(1.75\ \text{sfw})(.30) + .12 = \$0.645$$

$$\frac{\$0.645}{100\%-6\%} = \frac{\$0.645}{.94} = \$0.686$$

The total production cost for one 4 1/2" geranium is 69 cents.

470

- Calculate the wholesale price by multiplying the total production cost by a multiplier for your desired profit margin.

Desired Profit Margin	Multiplier
10%	1.11
15%	1.18
20%	1.25
25%	1.33
30%	1.43
35%	1.54

  - You want to make a 20% profit on the 4 1/2" geranium.

    ($.686)(1.25) = $0.86

  - Our wholesale price on a 4 1/2" geraniums will be 86 cents.

- Calculate the retail price by marking up the wholesale price by your desired profit margin. The 4 1/2" geraniums will retail for a 30% net profit margin over the wholesale price.

  ($.86)(1.43) = $1.23

  - The geranium will retail for $1.23 at our greenhouse.
  - Many growers double the wholesale price to determine the retail price; however, this number will often be too high.

- Once your prices have been determined don't "follow the leader" and change your prices.
  - All 4 1/2" geraniums are not the same. Your plants may be twice as big and have two more flowers per pot than the business down the road that is retailing plants for $1.00. Stress quality and dollar value to your customers, and in your advertisements.
  - If your prices are too far off base, recalculate the numbers and make sure no error occurred. If the figure is still too high look for the reason.

- Maybe you are growing the plants on too much space or have too many greenhouse employees. Maybe your greenhouse is not energy efficient and your heating bills are too high.
- Find any method to lower production costs so your business will remain competitive with other growers.

TIPS ON DEALING WITH THE MEDIA

- Be professional; maintain good contacts with local media.
- Any news releases should look neat and be free of grammatical errors.
- Photographs should accompany news releases if applicable.
- Don't expect every news release or event at your business to be published.
- Do **not** run any advertisements that have errors in them.
- Talk with the local media about how they prefer the advertisements for their media.
- Turn in ads well ahead of the deadline.

DETERMINE DIFFERENCES IN CUSTOMER NEEDS

Visit a mass market outlet such as a large supermarket or retail store, a retail nursery, and a florist shop.

Observe the similarities and differences between them. Notice such things as price, plant quality, and plant selection. Write down your observations.

	Size	Price	Plant Quality	Plant Selection
Mass Market				
Retail Nursery				
Florist Shop				

DEVELOPING A MARKETING STRATEGY

You are planning to open a greenhouse. Before going into business you need to do some planning. Determine what you think would be a good marketing strategy and write it below. The greenhouse will be a local operation.

Intended customers— ______________________

Marketing area— ______________________

Sales procedure— ______________________

Operating hours— ____

Advertising— ____

ASSIGNMENT SHEET 1

MARKETING GREENHOUSE PRODUCTS

IX

NAME ______________________________ SCORE ________

OBJECTIVE 11

Create a newspaper advertisement for a greenhouse.

INTRODUCTION

Objective 7 discusses the important points of successfully using newspaper advertisements to increase sales at your business. Use that information to create a newspaper advertisement.

DIRECTIONS

You have decided to run newspaper ads promoting poinsettias for the Christmas season. A meeting is scheduled with your advertising agent next week and you are asked to bring in a rough sketch of the type of advertisement you want to use.

Make a rough drawing of an advertisement you think would increase the number of poinsettias sold. Use a separate sheet of paper for your drawing. Remember the three main objectives of a good advertisement.

ASSIGNMENT SHEET 2

MARKETING GREENHOUSE PRODUCTS IX

NAME ________________________ SCORE ________

OBJECTIVE 12 **Determine the production cost and establish a selling price.**

INTRODUCTION Objective 10 lists the steps required to calculate the actual production cost for a crop; it also lists how to determine a fair selling price.

DIRECTIONS Use the information provided below to calculate the figures requested. The table lists the multipliers for various net profits.

Desired profit Margin	Multiplier
15%	1.18
20%	1.25
25%	1.33
30%	1.43
35%	1.54

1. A crop of 4" pansies are about ready for sale. They have been grown at a 5"x5" spacing for 10 weeks and the crop loss was 13%. It cost you 28 cents/sfw to operate your greenhouse and pansy seedlings cost 1.5 cents each. The desired profit margin on the plants is 20%.

   a. What is the total production cost of a 4" pansy? ______

b. What is your wholesale price on a 4" pansy?___________

2. The greenhouse is growing marigolds for wholesale sales in 806 cell packs in 11"x22" flats at a flat to flat spacing. It will take 6 weeks to produce a crop, and the seed cost 2 cents each. The operating cost of the greenhouse is 34 cents/sfw and a net profit of 35% is desired. Estimated crop loss is 5%.

   a. What is the production cost for a flat of marigolds? _____

   b. What is the wholesale selling price on a cell pack of marigolds?______________

3. Six inch pot mums are grown for 1 week at a 6"x6" spacing, 2 weeks at a 8 x 8 spacing and 7 weeks at a 12"x 12" spacing. Rooted cuttings cost 25 cents per pot and the greenhouse estimates its operating cost at 30 cents/sfw. The loss of mums is 1% and a net profit margin of 20% is desired.

   a. What is the total production cost for a 6" pot mum? _____

   b. What is the wholesale price of 6" pot mums? __________

ASSIGNMENT SHEET 1

Use the following criteria for evaluation:

- The ad must attract readers attention.
- It should inform the reader about their product.
- It must convince the reader to buy.
- It should have open space and not be jumbled.
- Artwork of some kind should be included.

ASSIGNMENT SHEET 2

1. a. Total production cost per 4" pansy is $0.58.

$$\frac{(5x5)}{144}(10) = 1.74 \text{ sfw}$$

$$(1.74 \text{ sfw})(.28) + .015 = \$.502$$

$$\frac{\$.502}{.87} = \$0.58$$

b. The wholesale price of a 4" pansy is $0.72.

$$(.58)(1.25) = \$0.73$$

2. a. Total production for a flat of marigolds is $4.62.

$$\frac{(11x22)}{144}(6) = 10.08 \text{ sfw}$$

$$(10.08 \text{ sfw})(.34) + .96 = \$4.387$$

$$\frac{\$4.387}{.95} = \$4.62$$

b. Wholesale price of a cell pack of marigolds is $0.89.

$$(\$4.62)(1.54) = \$7.11/\text{flat}$$

$$\frac{\$7.11/\text{flat}}{8 \text{ packs/flat}} = \$0.89/\text{pack}$$

3. a. Total production cost per 6" pot mum is $2.72.

$(8.14 \text{ sfw})(.30) + .25 = \$2.692$

$\frac{\$2.692}{.99} = \$2.72$

b. The wholesale price of a 6" pot mum is $3.40.

$(\$2.72)(1.25) = \$3.40$

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WRITTEN TEST

MARKETING GREENHOUSE PRODUCTS IX

NAME ______________________________ SCORE ________

OBJECTIVE 1

Select from a list true statements concerning marketing territory. Write an "X" in the blank before each true statement.

____ 1. Towns with rapidly developing businesses and industry are not good places to market greenhouse products because all the town's money is tied up in these businesses.

____ 2. Distance to a customer is a major consideration when developing a marketing territory.

____ 3. Most greenhouse truck routes cover a 500 mile radius.

____ 4. Evaluate the number of competitors in an area when you are developing your marketing territory.

____ 5. Consider the quality of roads and highways when evaluating a marketing territory.

____ 6. The number of customers in an area will determine if a delivery route is feasible to that area.

____ 7. The volume of products a customer buys should not affect delivery routes; trucks should go if the customer buys $5 or $500 of products.

OBJECTIVE 2

List potential buyers. Name the four potential outlets for greenhouse products.

OBJECTIVE 3 **Discuss customers' needs.**

1. Why should a greenhouse know its customers' needs?

2. Compare the type of products desired by a mass market to those of a retail garden center or nursery?

3. What effect does geographic location have on customer needs?

OBJECTIVE 4

Complete statements about available sales options. Fill in the blanks with the missing words.

1. Retail sales prices are charged to the general ______________ .
2. Wholesale prices are usually lower than the retail price by at least ________ percent.
3. Retail prices are higher because the greenhouse has to provide sales personnel to help customers with any ________________ they may have about the plants or products.
4. A commercial customer with a bad credit history will be required to pay __________ for all sales.
5. Credit sales do not require customers to pay for the product when they are ________________ .
6. Wholesale accounts receive a lower price because these customers purchase _____________ amounts of products from your greenhouse.
7. Most credit sales are to be paid in full in _________ days.
8. Bad checks may have to be written off as a ____________ .
9. Credit cards require extra bookkeeping personnel and a ______________ must be paid to file a charge.

OBJECTIVE 5

List factors that should be included in a marketing strategy.

____

____

____

____

____

OBJECTIVE 6

List examples of promotional aids and public relations.

1. List four examples of promotional aids.

____

____

____

____

2. List two examples of public relations.

____

____

OBJECTIVE 7

Select from a list true statements about factors that contribute to a good advertisement. Write an "X" in the blank before each true statement.

____ 1. Hire professionals to help you develop advertisements.

____ 2. Open space attracts readers and is easier to read.

____ 3. Advertisements should only be run once because of the expense.

____ 4. Include essential information such as store name and address.

____ 5. For maximum dollar value fill every inch of space in an advertisement.

____ 6. Advertisements only need to attract and inform customers of a product.

____ 7. Artwork should be included in print ads.

____ 8. Advertising is not a necessary expense.

____ 9. Advertisements should coincide with holidays or periods when people need your product.

___ 10. Any advertisement, even a poorly designed one, will increase sales.

OBJECTIVE 8

List methods of advertising. Write four methods in the space provided.

____

____

____

____

____

____

____

OBJECTIVE 9

Discuss maintainjng a customer list.

1. List ways to develop a customer list.

2. Why are customer lists useful?

OBJECTIVE 10

Discuss production cost and selling price.

1. What is "follow the leader" pricing?

2. How can a grower find out how much it cost per square feet week to operate a greenhouse?

NOTICE The following assignment sheets are not part of the written test. If these activities have not been completed, check with your instructor.

OBJECTIVE 11 **Create a newspaper advertisement for a greenhouse.** SCORE ________

OBJECTIVE 12 **Determine the production cost and establish a selling price.** SCORE ________

WRITTEN TEST ANSWERS

MARKETING GREENHOUSE PRODUCTS IX

OBJECTIVE 1

2, 4, 5, 6

OBJECTIVE 2

- Mass market outlets
- Retail nurseries and garden centers
- Florist shops
- Retail consumers

OBJECTIVE 3

1. So the greenhouse will have products available to meet the needs of customers.
2. Mass market wants small sized products, they don't care about cultivars and are not too concerned about the quality; they want a low price.

   Retail garden center and nurseries are quality orientated, and they may request specific cultivars and crops; they also want a good price.
3. A greenhouse must supply crops that are adapted to the area.

OBJECTIVE 4

1. public
2. 20
3. questions
4. cash
5. delivered
6. large
7. 30
8. loss
9. fee

OBJECTIVE 5

Answer should include:

- Intended customers
- Marketing area
- Sales procedure
- Operating hours
- Advertising

OBJECTIVE 6

1. Answer should include any four of the following:
    - Your business should be neat and clean.
    - Have a professional sign outside your business so customers will know where you are located.
    - All employees should wear uniforms that are neat and clean.
    - Delivery vehicles should be clean and should have the greenhouse's name professionally painted on the outside.
    - Display areas should be clean and well stocked.
    - Use attractive stationary and professional quality direct mail ads and invoices.
    - All sales personnel and employees should be polite, courteous and friendly toward the customers.
    - Advertising should be done with the help of a professional agency.
    - Giving away items like ink pens, rulers or magnets with your business's name is a good promotional tactic.
2. Answer should include any two of the following:
    - Writing a gardening column in your local newspaper once a week.
    - Providing gardening tips on a radio station.
    - Offering gardening tips on a telephone recording.
    - Providing plants for special community functions.

- Writing news releases of events at your business.

OBJECTIVE 7 1, 2, 4, 7, 9

OBJECTIVE 8 Answer should include any four of the following:

- Television
- Radio
- Local newspaper
- Direct mailing
- Telephone yellow pages
- Point of purchase displays

OBJECTIVE 9

1. - Customers fill out a form
   - Collect names from checks that are written at the greenhouse
   - Use door prizes to get customers' names
   - Garden club members
2. - Direct mail advertising
   - Give good customers special bonus
   - Increase the value of a business

OBJECTIVE 10

1. Waiting for your competitor to price their products and then charging the same prices.
2. Calculate total expenses for a year.

   Divide total expenses by 52 to get the cost per week.

   Divide cost/week by total square footage of the benches to find out how much it costs per week per square feet of growing space.

OBJECTIVE 11 Refer to answers to Assignment Sheet 1.

OBJECTIVE 12 Refer to answers to Assignment Sheet 2.

OBJECTIVE SHEET	SHIPPING AND RECEIVING GREENHOUSE PRODUCTS	X

INTRODUCTION

The transportation of greenhouse products from sellers to buyers is a complicated business. Greenhouse growers must be able to quickly and reliably receive the plants and hardgoods required to produce their crop. The crop must then be transported to many different customers. Often a greenhouse product will be shipped again from the retailer to the final consumer destination.

UNIT OBJECTIVE

After completing this unit, the student should be able to prepare and package an order for shipping, and then deliver the product to its destination without damage or injury. The student will demonstrate these competencies by completing an assignment sheet, job sheet and written test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Discuss preparing an inventory of salable products.
2. Discuss selecting plants that are ready for sale.
3. Select from a list items that should be included on the customer tag.
4. Identify packaging procedures.
5. Discuss loading delivery trucks for drop shipments.
6. Discuss methods of transporting products.
7. Select from a list true statements about checking received merchandise against the listed invoices.
8. Discuss filing a damaged merchandise report.
9. Write a loading order for a delivery truck route. (Assignment Sheet 1)
10. Demonstrate the ability to sleeve a potted plant. (Job Sheet 1)

SUGGESTED ACTIVITIES

SHIPPING AND RECEIVING GREENHOUSE PRODUCTS

X

PREPARATION

- Obtain materials to supplement unit.

  NOTE: See Suggested Resources.

- Review instructional outline for this unit. Modify time frames to suit class needs and plan activities for each class period.
- Study the specific objectives to determine those you will cover in your presentation. Decide which objectives should be taught to which students.
- Determine scope and sequence of objectives that you add. Design and develop support materials, including evaluation techniques, for additional objectives.
- Determine how you will schedule time for students to demonstrate competence in the required procedures.
- Make arrangements for guest speakers. Supply speakers with specific objectives and other appropriate sections of the unit.

DELIVERY

Objectives 1 and 2

- Introduce the topic of shipping and receiving greenhouse products. Discuss the importance of shipping and receiving to a greenhouse business.
- Discuss preparing an inventory of salable products.
- Discuss plants that are ready for sale.
- Walk through the greenhouse and show students how to determine salable plants.
- Have a greenhouse operator talk to the class about shipping and delivery procedures at his or her greenhouse.

Objectives 3 and 4

- Discuss items that should be included on the customer tag. Stress the importance of proper labeling of greenhouse products.
- Discuss packaging procedures.

- Demonstrate to students how to sleeve plants.

Objectives 5 and 6

- Discuss loading delivery trucks for drop shipments.
- Discuss methods of transporting products. Ask students what methods they think are most common in your area.

Objectives 7 and 8

- Discuss checking received merchandise against the listed invoices.
- Discuss filing a report of damaged merchandise. Ask students what they think would constitute damaged merchandise.
- Bring to class or show pictures of several greenhouse items and plants that range from slightly damaged (small tear in package) to extremely damaged (dead plant). Have students discuss how they would handle the problem and if they would file a claim for damaged merchandise.

APPLICATION

Objective 9

- Use Assignment Sheet 1 to teach students how to plan a truck route and write a loading order. Provide students with Oklahoma maps.

Objective 10

- Use Job Sheet 1 to allow students to learn how to sleeve potted plants.

EVALUATION

Practical Test

- Explain to students that they will be asked to deomonstrate procedures on the job sheets to complete the practical test.
- Describe the rating scale used on the practical test.
- Give practical test.
- Reteach and retest as necessary.

Written Test

- Explain to students that they will be asked to demonstrate on the written test actions listed in the specific objectives.

- Complete appropriate section of competency profiles.
- Review individual and group performance in order to evaluate teaching methods. Adjust scope, sequence, or instructional approaches for additional lessons as required.

SUGGESTED RESOURCES

- Obtain sleeves.
- Obtain Oklahoma state maps for student use.
- Collect color plant tags for display.
- Collect various types of shipping containers.
- IDECC Marketing Education LAP DE 3061 OK1 Shipping and Receiving.

  NOTE: This Learning Activity Packet is available from the Curriculum and Instructional Materials Center, Oklahoma Department of Vocational and Technical Education, 1500 W. Seventh Avenue, Stillwater, Oklahoma 74074, 1-800-522-5810, ext. 589.

UNIT REFERENCES

- Colton, Richard C. and Edmund S. Ward, *Practical Handbook of Industrial Traffic Management*, 3rd. ed., The Traffic Service Corporation, New York, New York, 1959.
- Langhans, Robert, *Greenhouse Management*, 2nd. ed., Halcyon Press of Ithaca, Ithaca, New York, 1983.
- Laurie, Alex, at al., *Commercial Flower Forcing*, 8th. ed, McGraw-Hill Inc., New York, New York, 1979.
- Nelson, Kennard, *Flower and Plant Production in the Greenhouse*, The Interstate Printers and Publishers, Inc., Danville, Illinois, 1967.

BASIC ACADEMIC SKILLS

The following table identifies the basic academic skills that are reinforced in this unit of instruction. These basic academic skills were identified using *The Basic/Essential Skills Taxonomy*, 2nd edition, and verified during the validation process.

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 1	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
	Science 378	Describes/ Explains	Plants	
	Science 382	Describes/ Explains	Plants	Parts/ functions
	Free Enterprise 110	Describes/ Explains	Merchandising	
OBJECTIVE 2	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
	Free Enterprise 110	Describes/ Explains	Merchandising	
OBJECTIVE 3	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity
OBJECTIVE 4	Language Arts 013	Applies/Uses	Definitions	
	Science 043	Applies/Uses	Models/ theories/laws	

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 5	Language Arts 098	Composes/ Edits	Reports/ essays	Summaries
OBJECTIVE 6	Language Arts 098	Composes/ Edits	Reports/ essays	Summaries
	Language Arts 038	Collects/ Organizes	Information-oral/written	
OBJECTIVE 7	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity
OBJECTIVE 8	Language Arts 098	Composes/ Edits	Reports/ essays	Summaries
OBJECTIVE 9	Language Arts 035	Attends	Directions/ task	
	Science 042	Applies/Uses	Maps/charts/ tables/graphs	
	Mathematics 097	Constructs	Charts/tables/ Graphs	
	Mathematics 229	Solves problems	Generate conclusions	Deductive reasoning
OBJECTIVE 10	Language Arts 035	Attends	Directions/ task	
	Language Arts 013	Applies/Uses	Definitions	

OBJECTIVE 1

Discuss preparing an inventory of salable products.

An entire crop does not become salable on one precise date. Depending on the size of the crop, and the temperature fluctuations within the greenhouse, a seven to ten day difference may exist between the first and last salable plants.

- Determine the qualifications for a salable plant. The requirements for a salable plant vary with the plant species.
    - Bedding plants will be well established and ready to transplant outdoors. Unfortunately, consumers prefer a plant that is showing color.
    - Blooming pot mums should have at least 50% of the flowers fully opened.
    - Potted lilies should be in the puffy bud stage before any blooms are open.
    - Poinsettias should have expanded bracts. They should be sold before the flowers mature.
    - Foliage plants should be compact and full.
- Take a quick visual inventory daily during the busy season. This will tell you how many plants out of the total crop are ready for sale.
- Estimate the number of plants that you expect to be ready for sale in the next few days.

  EXAMPLE: Ray tells the manager that there are 150 4" geraniums ready for sale today and another 250 pots will be ready over the next 3 days.

- Projected numbers of salable containers let the manager estimate if there will be enough product available for their customers.

EXAMPLE: The greenhouse has been selling 100 to 110 4" geraniums per day. The weekend is only two days away and Saturday's estimated geranium sale is 250 pots. The manager decides the greenhouse is short on 4" geraniums so they had better order 200 4" geraniums from the wholesaler for delivery on Friday.

- Chemicals and garden supplies should be monitored closely during the peak sales period. These materials are frequently purchased in large amounts when plant sales are in full swing.
  - If supplies are running low a special order may need to be made.

OBJECTIVE 2 **Discuss selecting plants that are ready for sale.**

The qualifications for a plant being ready for sale were discussed in Objective 1. These plants should be shipped or sold first.

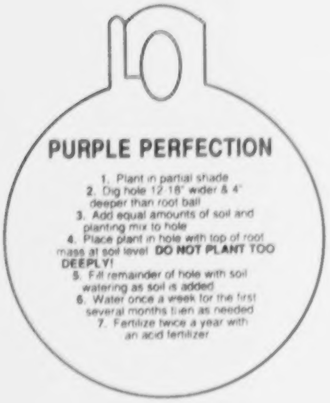
- Most retail operations move salable plants from the growing area to the sales or display area.
  - These plants can be moved manually using carts, monorail or conveyers to the retail area.
  - Moving plants is a major labor expense but salable plants must be put on display in the retail area. If they are left in the production area customers will damage the nonsalable plants trying to pick out the salable ones.
  - Removing salable plants from the production bench will often speed up the development of the remaining plants; they receive more sunlight and warmer temperatures.
- Salable plants should generally be in the same developmental stage; all geraniums have one flower open or have color showing in the buds.
  - For small sized greenhouse operations, plants in cell packs can be switched to make sure all packs have at least one bloom. This is time consuming but will increase sales if the crop is slow in maturing.
- Salable plants that will be shipped to wholesale customers should be moved to a collective area where the shipping personnel can quickly fill the customers' orders.

OBJECTIVE 3

Select from a list items that should be included on the customer tag.

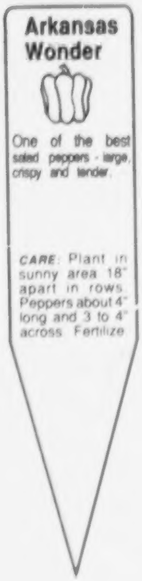
Consumers are very interested in cultural information on the plants they are purchasing.

- Labeling information should include:
  - plant name
  - light requirement
  - water needs and any other special cultural requirements
- Wholesale customers usually require each pot or pack to be labeled.
  - This eliminates the need for wholesale customers having to supply the information to the customers. It also eliminates any mix up of cultivars once they receive the plants.
- Preprinted labels are available from seed companies and plug producers.
  - These tags are brightly colored and contain the information a consumer needs.
  - Growers buy preprinted tags because they are convenient to use; they stick one in each pot or pack at planting time and the labeling is completed.



PURPLE PERFECTION

1. Plant in partial shade
2. Dig hole 12-18" wider & 4" deeper than root ball
3. Add equal amounts of soil and planting mix to hole
4. Place plant in hole with top of root mass at soil level **DO NOT PLANT TOO DEEPLY!**
5. Fill remainder of hole with soil watering as soil is added
6. Water once a week for the first several months then as needed
7. Fertilize twice a year with an acid fertilizer



Arkansas Wonder

One of the best salad peppers - large, crispy and tender.

CARE: Plant in sunny area 18" apart in rows. Peppers about 4" long and 3 to 4" across. Fertilize

- Additional information will need to be supplied if the plants are retailed.
  - Signs are usually placed near the plants telling the consumer which plants are annuals or perennials and if they bloom in the spring, summer or fall.
  - This extra information makes the buyer knowledgeable and improves their success rate with plants which means repeat sales for the greenhouse.

OBJECTIVE 4

Identify packaging procedures. (Activity Sheet 1)

When greenhouse crops are being prepared for shipping they must be packed to protect the plants from damage during transportation. The type of packaging needed will depend on the plant species and the time of year.

- Sleeving is used for potted plants like mums, lilies, poinsettias and hydrangeas.
  - Sleeves are vase shaped tubes that are open on both ends. These sleeves are slipped over the growing container and pulled up over the foliage.
  - Growing containers hang partially out of the bottom of the sleeve; this allows the container to stand upright.
  - Sleeves hold the foliage and flowers together and prevent them from being broken during the loading and transporting procedure.
  - Sleeves can be purchased in paper, plastic or woven mesh in a variety of sizes and dimensions.
  - Paper allows the plants to transpire without moisture collecting, but a customer cannot see through the sleeve. Plastic sleeves are opaque so they can be seen through, but they collect moisture if the humidity is high. Mesh sleeves allow the plant to get air and light, and the customer can see the product.
  - Sleeves are very durable. Plants can be picked up and carried by the sleeve which makes loading and unloading trucks a lot easier. One person can easily carry eight plants at a time.
  - Sleeves that have your business's name printed on the outside are available from specialized companies.

- Sleeve stands are needed to quickly put sleeves on plants. These stands are usually designed and constructed by the greenhouse personnel.
- Major requirements for a good stand are:

  Stability, so it doesn't tip over while it is being used.

  Comfortable working height that does not require employees to stoop over while using the stand.

  Pot holder that is large enough to hold several sizes of pots; usually 5, 6 and 8 inches.

  Easily transportable if one stand is to be used in several different greenhouses. Locking wheels on the base will make the stand movable yet keep it steady when it is being used.
- Sleeves are always pulled up from the bottom of the pot and over the foliage. Retail customers should be told to tear or cut sleeves off the pot when they get the plant home; pushing a plant out of the sleeve can cause breakage.
- Plants that are sleeved for local shipping are usually not placed in any other type of packaging container. Small sized pots are placed inside cardboard boxes or trays so a large number of pots can be efficiently transported.
- Customers' names are written on the outside of sleeves for easy delivery.

- Cardboard boxes are used as packaging containers for large "specialty" crops such as blooming hanging baskets, gloxinias and tree poinsettias. These plants cannot be easily sleeved.
  - Cardboard boxes are also used to ship potted plants long distances. The sleeved pots are placed inside cardboard boxes and shipped. This gives the plants extra protection during the long transportation period.
  - Boxes are usually custom made to snugly hold plants in place.
  - Large plants and hanging baskets are packed in boxes, usually two plants per box, and shipped. They require a higher sales price because of the added packing and shipping cost.

  - If these types of plants are delivered to local customers, hanging baskets may be hung on special racks in the delivery truck. Many growers devise special shelves or pot holders for transporting large pots to local customers without any packaging.
  - A delivery driver must be careful so plants are not broken during transport and unloading.

- Cardboard boxes that layer plants are used for small pots.
  - These specially designed boxes hold several layers of small pots. Layering does not hurt the plants and it allows the grower to ship 2-3 times the number of plants in the same amount of shipping space.
  - Plugs and seedling trays are also shipped in boxes that layer the trays. Normal packaging cartons for plug trays contain 4-5 layers of plants held securely in place.
  - Shipping costs are inexpensive for plugs and seedlings because so many plants are contained in one box.

- No packaging is used for shipping bedding plants.
  - Flats of cell packs are loaded onto shelves in the delivery truck.
  - Plants grown in flats are not very tall so the shelves can be spaced 12-15 inches apart in the truck.

- Special styrofoam, or styrofoam lined, cardboard boxes must be used to ship temperature sensitive plants, especially during cold weather.
  - African violets and foliage must be protected by these special cartons.
  - Delivery charges are often higher in the winter months due to extra packaging precautions.

- All plants should be thoroughly watered and have dry foliage before they are packaged for shipment.
  - It is not uncommon for plants to be in the shipping cartons for 3-4 days. Disease may develop if the foliage is wet when the plants are put in the cartons.

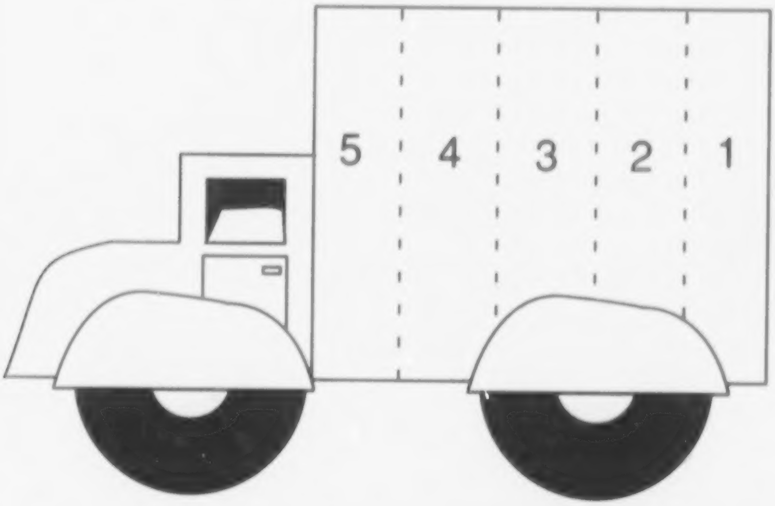
- All plants should be securely and correctly labeled before being placed into the shipping container.
  - Labels should be pushed at least half way into the media of pots and hanging baskets.
  - Labels should be stapled to plug or seedling trays so the labels cannot be jarred loose during shipment.
- Diseased or insect infested plants should not be shipped. These pathogens will quickly spread through the entire carton during shipping.
- Sleeves should be folded and stapled shut during cold weather.
- Cardboard flats are generally used to transport plants purchased by retail customers.
  - These flats can be purchased from box companies.
  - Many retail customers do not want packaging for their purchases since they are only traveling short distances.

OBJECTIVE 5 **Discuss loading delivery trucks for drop shipments.**

Every delivery driver should have a predetermined list of delivery stops. The truck driver will know exactly what to deliver first and last. This is important because trucks are loaded according to the delivery stops.

- A drop shipment delivery system means the truck drives to a customer's business and drops off their order and then drives to the next customer and does the same thing.
  - A delivery truck may make 30 drop shipments in one day on a single route.
- Trucks are loaded in reverse order of the delivery stops.
  - The last delivery stop is loaded onto the truck first and the first delivery stop is loaded last.

- Orders should be placed in the truck or trailer from front to back; the first plants placed in the truck, or trailer, are placed closest to the cab.



- This loading order makes it easy for the delivery person to unload each customer's order. At the first delivery stop the truck is opened and the order is right inside the door; as the driver continues on the route the current customers' order is always clearly visible.

- A customer's order is grouped together and labeled so the driver can easily see what needs to be unloaded.
  - Some businesses use ribbon or string to mark off each order. Others don't worry about separating orders so clearly.
  - The competency of the delivery person will dictate how well the orders must be segregated.
- A clipboard of invoices will be loaded into the truck. The delivery person should always check the labeled order against the invoice to make sure all the products have been unloaded.
  - The customer will sign the invoice when the products are delivered, and the driver keeps a copy. This invoice is like a contract; it states what products the customer received and at what cost.

- Delivery vehicles are usually loaded the night before the delivery. The plants and products are packed in the late afternoon and placed in the vehicle.

- Small sized items like chemicals, rooting hormone, tools, etc. should be placed together in a paper sack or box and labeled.

  - This makes delivery of these items easier for the driver, and it also guarantees that the customer will get all ordered items.

OBJECTIVE 6

Discuss methods of transporting products.

Greenhouse products can be shipped using either air or ground transportation methods. The grower must decide which method is needed, and then find the least inexpensive way to reach the target destination.

- Several factors will determine if a product will be transported using air delivery.

  - Perishability of the product. Cut flowers from Europe or South America must be flown into the United States.

  - Distance between the buyer and seller. Microcuttings from Florida being shipped to Portland, Oregon must be sent by air; they would not survive four days in a truck.

  - The size of the target city. Big cities like Denver, Dallas, Chicago, Boston and Los Angeles have hundreds of flights in and out every day. It is cheaper to fly products into those cities than into cities like Lexington, Kentucky or Columbus, Ohio.

  NOTE: Air freight is the most expensive shipping method and should be used only when absolutely necessary. All major airlines will accept cargo. Call the airlines at the nearest airport for price quotations. They usually have weight and size restrictions.

- Ground transportation is the most commonly used method of shipping.

  - It can be used for any product that is not highly perishable or needed quickly.

  - It is an inexpensive form of shipment.

  - Customers prefer ground transportation because orders are usually delivered right to their doorstep. Air freight has to be picked up at the airport.

- Sources of ground transportation are:
  - Local trucking companies that deliver within a limited area.
  - National truck carriers that deliver anywhere in the Unites States.
  - UPS and Federal Express trucks deliver anywhere in the United States, usually in 4-5 days. They now offer one or two day delivery but it is more expensive.
  - Bus companies also deliver freight. This is particularly good for deliveries to small towns in your state; often the delivery can be made within several hours.
  - Greenhouse owned delivery trucks are frequently used.

- Ground transportation is popular because:
  - Most greenhouses that deliver products have their own delivery van or truck. This is by far the most economical way to ship merchandise.
  - Special orders, emergency shipments or missed deliveries occasionally will have to be sent out. Other forms of ground transportation are excellent for these shipments.
  - Customers not on a regular greenhouse delivery route can be reached using UPS or bus service.

    NOTE: Obtain rate schedules from the different companies to see which one is the least expensive.
  - Shipments received at your greenhouse will come through these same shipping carriers.

    NOTE: Customers sometimes prefer a certain form of shipping. Many sellers ask their customers how they would like the order to be shipped.

OBJECTIVE 7

Select from a list true statements about checking received merchandise against the listed invoice.

Comparing the products delivered with the delivery invoice will eliminate problems of incorrect deliveries and improper charges.

- Personnel who receive merchandise should always compare the products delivered with the delivery invoice before accepting the products.
  - Small mistakes are easily made when large orders are delivered; 10 bags of 20-10-10 are unloaded instead of 20-10-20 or five cases of 6" pots are unloaded and six cases were ordered.
  - Corrections can usually be made while the delivery person is still there; the wrong fertilizer was loaded back on the truck and the correct type unloaded, or one case of pots was pulled from the truck.
  - Many people put a check mark beside each item on the invoice as it is checked.
- Freight companies require the person to accept delivery of broken or damaged items. However, note the damaged material on the invoice. Call the company representative and begin the claim process.
  - Have the delivery person initial or sign the invoice where the correction was made.
- With major errors, ask the delivery person to call their office and get instructions on what to do.
- Items from a local company that are broken, damaged or of poor quality when delivered should be refused.
- Once the invoice has been signed you have accepted the items as stated on the invoice.
  - If you find a broken or missing product after accepting the order it may be difficult to correct the problem.
  - Suppliers do not like to refund money for missing products when the signed invoice indicates the complete order was delivered.

OBJECTIVE 8

Discuss filing a damaged merchandise report.

Occasionally there will be plants or products that get damaged or broken during shipping. This is unavoidable when products are being transported long distances.

- A damaged merchandise claim of some type will have to be filled out to replace the damaged products or get a refund.
- Claim forms will vary with each company. The type of claim form will also vary depending on the method of shipping used.
- Small businesses that deliver their own products will usually replace, or credit, damaged merchandise when the delivery is made.
  - If you find damaged products after the delivery person has left, call the company office and talk with the sales representative about the problem. These people know you and are usually very anxious to correct the problem.
- Large businesses ship their products all over the country and are not familiar with individual customers.
  - When damaged merchandise is received call the sales representative and explain the situation. Some companies will replace the damaged merchandise themselves while others require the shipping company to replace damaged goods.
- Live plants that are injured or killed during shipping should be reported to the seller immediately upon arrival.
  - If the plants were shipped by an air freight company they may send an adjuster to your business to inspect the damage.
- To increase your chances of success in filing a damage claim, notify the seller immediately.
  - Businesses are very hesitant to replace damaged products that were not immediately reported.
- Talk with the company representative to inquire about filing a damage claim.
  - The sales representative will help you file the claim.

- Do not discard any damaged products until you find out if they must be returned or if an adjuster will need to look at them.
- Fill out the damage report promptly.
  - Accurately state what type of damage occurred and what portion of the total order was ruined. **Be honest!**
  - Complete the entire form; do not leave any questions blank.
  - Return the completed form to the responsible party.
- Wait a reasonable amount of time for the claim to be processed.
  - If you have not received reimbursement, or replacement items, within four to six weeks contact the responsible party and discuss the matter.
  - Contact the seller if you have any problems collecting from the shipping company. Sometimes the seller can help speed up the claim.

DESIGN A SLEEVE STAND

INTRODUCTION

Sleeving potted plants is the best way to prepare and package plants for shipment. Objective 4 discusses the importance of a stable and durable sleeving stand that may or may not be movable. Almost all greenhouses design a sleeve stand to fit their situation.

DIRECTIONS

Discuss with your classmates the type of sleeve stand that should be built for your school greenhouse. On a separate sheet of paper draw a rough sketch of your idea for a stand. Make a list of the materials needed, and then briefly describe how the stand will be assembled.

ASSIGNMENT SHEET 1

SHIPPING AND RECEIVING GREENHOUSE PRODUCTS

X

NAME ______________________________ SCORE _______

OBJECTIVE 9

Write a loading order for a delivery truck route.

INTRODUCTION

Objective 5 discusses the proper way to load a delivery vehicle so it will be easy to unload. Use the information in Objective 5 to complete this assignment sheet.

DIRECTIONS

Use the information provided with each question to determine the requested answer.

Your greenhouse has just gained enough new customers to start another truck delivery route. Your business is located in Stillwater and the new East route has customers in Perry, Tonkawa, Ponca City, Pawhuska, Cleveland, Hominy, Blackwell, Mannford and Yale.

1. Determine how the route will be delivered and draw a rough map showing the delivery stops. Using a separate sheet of paper, number the towns to show the first delivery stop, the second, and so on to last delivery stop.

   Here are the customer orders for this week on the new East route.

Blackwell Greenhouse	30	4" red geraniums
	6	yellow pot mums
Cleveland Ace Hardware	25	flats assorted bedding plants
Hominy Florist Shop	12	4" African Violets
	6	6" yellow pot mums
	6	6" white pot mums
Mannford Plant House	25	flats vinca
	10	flats orange marigolds
	12	6" red geraniums
Pawhuska Farmers Co-op	10	flats marigolds mixed colors
	12	10" impatiens hanging baskets
	25	4" red geraniums
	10	4" white geraniums
	3	flats tomatoes
Perry Flower Hut	10	8" foliage plants
	15	10" foliage hanging baskets
	12	6" white pot mums
	6	6" purple pot mums

Ponca City Greenhouse	10	flats yellow margolds
	15	flats vinca
	15	flats portulaca
	10	flats petunia (5 red and 5 white)
	75	4" red geraniums
	25	6" red geraniums
Tonkawa IGA	30	flats bedding plants
	50	4" red geraniums
	5	flats tomatoes
	2	flats peppers
Yale Florist	6	6" yellow pot mums
	6	6" white pot mums
	12	6" red geraniums
	3	10" pothos hanging baskets

2. A new driver will be delivering this route so prepare a list of how the orders should be loaded into the truck and what products will be delivered to each customer. Fill out the form showing in what order to load the truck and what products to deliver to each customer. Note: If a customer orders bedding plants they expect you to decide what types to send; always send at least three different species.

Truck loading order	Customer name	Location	Items to be delivered
1 (first)			
2)			
3)			
4)			
5)			

Truck loading order	Customer name	Location	Items to be delivered
6)			
7)			
8)			
9 (last)			

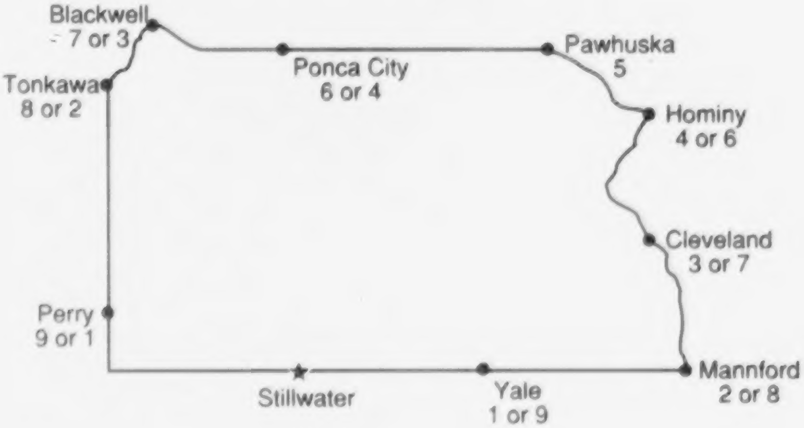
ASSIGNMENT ANSWERS | SHIPPING AND RECEIVING GREENHOUSE PRODUCTS | X

ASSIGNMENT SHEET 1

Use the following criteria for evaluation.

1. The student must understand that the delivery route should make a continuous loop so the fewest miles are driven.

   The route can have the first delivery in Yale and the last delivery in Perry or start in Perry and end in Yale; either way is satisfactory as long as it is the loop drawn below.


Blackwell
7 or 3
Ponca City
6 or 4
Pawhuska
5
Tonkawa
8 or 2
Hominy
4 or 6
Cleveland
3 or 7
Perry
9 or 1
Stillwater
Yale
1 or 9
Mannford
2 or 8

2. The list must be loaded in reverse order of the student's stated delivery route; last delivery stop loaded first and first delivery stop loaded last.

   Students should understand the importance of reverse loading.

   A loading order should be clearly written so shipping personnel can accurately fill the orders.

   Customers who ordered assorted flats of bedding plants should have received at least three species of good selling bedding plant varieties.

JOB SHEET 1

SHIPPING AND RECEIVING GREENHOUSE PRODUCTS

X

OBJECTIVE 10

Demonstrate the ability to sleeve a potted plant.

INTRODUCTION

The quality of a delivered potted plant is affected by how a sleeve was applied. Carelessly applying a sleeve or using the wrong size sleeve will damage the plant.

EQUIPMENT AND SUPPLIES

- Sleeve stand
- Sleeves
- Potted plants

PROCEDURE

1. Make sure plants have been well watered in advance of sleeving.
2. Place a group of sleeves on the stand.
3. Place a plant on the pot holder of the stand.
4. Grasp the inside sleeve from the group of sleeves and pull it up toward the pot.
5. Pull the sleeve up and over the foliage. If any branches or leaves get caught on the sleeve edge, gently push them inside.
6. Continue pulling the sleeve up around the plant until the plant is lifted off the pot holder; set the sleeved plant in the shipping area.
7. Several inches of pot should stick out of the bottom of the sleeve. If no pot shows, the sleeve is too small for the pot; if the pot almost falls out of the opening, the sleeve is too big.
8. The pot should be held securely by the sleeve while it is being carried.
9. Put away equipment and supplies and clean work area.

PRACTICAL TEST 1

SHIPPING AND RECEIVING GREENHOUSE PRODUCTS

X

JOB SHEET 1

Demonstrate the ability to sleeve a potted plant.

Student's Name ______________________ Date __________

Evaluator's name ______________________ Attempt no. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Made sure plants were well watered several hours before sleeving time.	_____	_____
2. Placed a group of sleeves on the stand.	_____	_____
3. Placed the plant on the pot holder of the stand.	_____	_____
4. Grasped the inside sleeve from the group of sleeves and pulled it up toward the pot.	_____	_____
5. Pulled the sleeve up and over the foliage. If any branches or leaves got caught on the sleeve edge, gently pushed them inside.	_____	_____
6. Continued pulling the sleeve up around the plant until the plant was lifted off the pot holder; set the sleeved plant in the shipping area.	_____	_____
7. Several inches of pot stuck out of the bottom of the sleeve.	_____	_____
8. The pot was held securely by the sleeve while it was being carried.	_____	_____
9. Put away equipment and supplies and cleaned work area.	_____	_____

EVALUATOR'S COMMENTS

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key). A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Sleeves selected properly	4	3	2	1
Plants handled properly	4	3	2	1
Plants sleeved without damage	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training

3 - Moderately skilled—Has performed job during training program; limited additional training may be required

2 - Limited skill—Has performed job during training program; additional training is required to develop skill

1 - Unskilled—Is familiar with process; but is unable to perform job

NAME ______________________ SCORE ________

OBJECTIVE 1

Discuss preparing an inventory of salable products.

1. Discuss the qualifications for the following crops to be considered ready for sale.

   Easter lily— ______________________

   Poinsettia— ______________________

   Bedding plants— ______________________

   Pot mum— ______________________

2. How can a daily inventory of salable products prevent the business from running out of a product?

   ____

OBJECTIVE 2

Discuss selecting plants that are ready for sale.

Why are salable plants usually moved from the growing area to the sales area at a retail greenhouse?

____

OBJECTIVE 3

Select from a list items that should be included on the customer tag. Write an "X"in the blank before each item that should be included on the customer tag.

____ 1. Transplanting date

____ 2. Sowing date

____ 3. Cultivar name

____ 4. Amount of sunlight required

____ 5. Breeder's name

____ 6. Water requirements

____ 7. Growth retardant used

____ 8. Special cultural requirements

____ 9. Days required for seed germination

OBJECTIVE 4

Identify packaging procedures. Write the letter of the correct packaging procedure in the blank before each crop.

____1. Poinsettia tree

____2. 6" poinsettia

____3. Plug trays

____4. Flat of marigolds

____5. Seedling tray

____6. Pot mum

____7. Gloxinia

____8. 3" cacti

a. Sleeves

b. Cardboard box

c. Cardboard box divided into layers

d. No packaging

OBJECTIVE 5

Discuss loading delivery trucks for drop shipments.

1. Define drop shipment delivery.

____

____

____

____

____

____

2. Describe how to properly load a delivery truck for a route that has seven drop delivery stops. Draw a picture showing the customer orders on the loaded truck.

____

____

____

____

3. When are delivery trucks normally loaded?

____

____

____

____

____

____

4. How can a customer's order be identified so the delivery person can quickly unload the order?

____

____

____

____

____

OBJECTIVE 6

Discuss methods of transporting products.

1. What type of products should be shipped by air freight?

2. Name three ways products can be shipped using ground transporation.

3. Discuss reasons why ground transportation is the most commonly used method of shipping.

OBJECTIVE 7

Select from a list true statements about checking received merchandise against the listed invoice. Write an "X" in the blank before each true statement.

____ 1. Some delivery errors can be corrected while the delivery person is at your business.

____ 2. Companies are honest and carefully pack all orders before they are shipped so there is no need to check your order.

____ 3. Every item should be checked and confirmed before the invoice is signed.

____ 4. In case of an error, note it on the invoice and have the delivery person sign the invoice.

____ 5. Accept a damaged or broken item from a local company when it's delivered and file a damage claim later.

____ 6. Once you sign an invoice you have accepted the items as stated on the invoice.

OBJECTIVE 8

Discuss filing a damaged merchandise report.

1. Why are damaged merchandise reports filed?

2. When should damaged products or merchandise be reported?

3. Who should the damaged product be reported to?

4. Can damaged merchandise be discarded?

NOTICE The following assignment sheet and job sheet are not part of the written test. If these activities have not been completed, check with your instructor.

OBJECTIVE 9 **Write a loading order for a delivery truck route.** SCORE ________

OBJECTIVE 10 **Demonstrate the ability to sleeve a potted plant.** RATING ________

WRITTEN TEST ANSWERS

SHIPPING AND RECEIVING GREENHOUSE PRODUCTS

X

OBJECTIVE 1

1. **Easter lily**—puffy bud stage without open blooms

   Poinsettia—bracts expanded but before flower matures

   Bedding plants—well established and ready to transplant

   Pot mum—at least 50% of the flowers fully opened

2. By estimating the amount of a product you will have ready for sale in a few days. If the quantity is too low you can quickly order more products from a wholesaler.

OBJECTIVE 2

So customers won't damage the nonsalable plants trying to reach the salable ones; it also helps the slower plants develop faster.

OBJECTIVE 3

3, 4, 6, 8

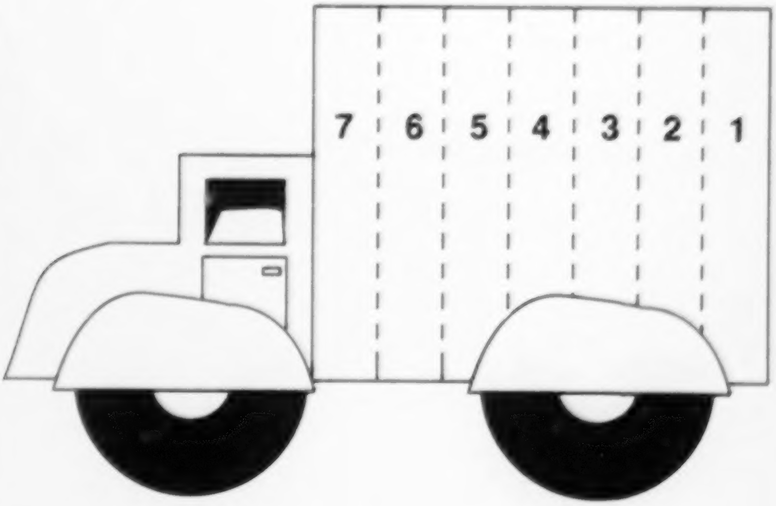
OBJECTIVE 4

1. b
2. a
3. c
4. d
5. c
6. a
7. b
8. c

OBJECTIVE 5

1. A truck drops off several items at a customer's business and then drives to the next customer where other items are dropped off. The truck continues on until all the items in the truck are delivered.

2. Load it in reverse order of how the deliveries will be made. The last delivery stop is loaded first and the first delivery stop is loaded last.



3. The night before the deliveries are to be made.
4. Write customer's name on the sleeve, box or bag and group the order together in the truck.

OBJECTIVE 6

1. Highly perishable products and perishable products that have to travel a long distance.
2. Answer should include any three of the following:
   - Local trucking companies
   - National truck carriers
   - UPS and Federal Express
   - Bus companies
   - Greenhouse owned delivery trucks
3. Answer should include the following key points:
   - It can be used for any product that is not highly perishable, or needed quickly.
   - It is an inexpensive form of shipment.
   - Customers prefer ground transportation because their order is usually delivered right to their doorstep.

OBJECTIVE 7	1, 3, 4, 6
OBJECTIVE 8	1. So a replacement product will be sent, or your account will be credited for the product. 2. Immediately upon arrival. 3. The seller. If they don't handle the claims they will tell you who to contact. 4. Not until it's known if the product must be returned or if it will be inspected by an adjuster.
OBJECTIVE 9	Refer to answers to Assignment Sheet 1.
OBJECTIVE 10	Refer to Practical Test for Job Sheet 1.

OBJECTIVE SHEET

CUSTOMER RELATIONS

XI

INTRODUCTION

Most consumers decide to patronize a business based on its physical appearance and how they are treated by the employees. It is estimated that over one-half of customers who stop shopping at a business do so because of the indifferent attitude of the sales personnel. A successful business must be visually appealing and have courteous, helpful employees.

UNIT OBJECTIVE

After completing this unit, the student should be able to attractively display greenhouse products and effectively use sales techniques when working with customers. The student will demonstrate these competencies by completing an assignment sheet and the written test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Discuss arranging store displays.
2. Select from a list true statements about designing display racks.
3. Discuss greeting customers.
4. Discuss conducting a sale.
5. Complete statements about sales transactions.
6. Discuss packaging customer orders.
7. Select from a list true statements about how to handle customer complaints and returns.
8. Analyze customer relations situations. (Assignment Sheet 1)

PREPARATION

- Obtain materials to supplement unit.

  NOTE: See Suggested Resources.

- Review instructional outline for this unit. Modify time frames to suit class needs and plan activities for each class period.
- Study the specific objectives to determine those you will cover in your presentation. Decide also which objectives should be taught to which students.
- Determine scope and sequence of objectives that you add. Design and develop support materials, including evaluation techniques, for additional objectives.
- Determine how you will schedule time for students to demonstrate competence in the required procedures.
- Make arrangements for guest speakers. Supply speakers with specific objectives and other appropriate sections of the unit.
- Make arrangements to tour local greenhouses.
- Develop a slide set of effective and ineffective displays.

DELIVERY

Objectives 1 and 2

- Introduce the topic of customer relations. Stress the importance of good customer relations to a business.
- Discuss arranging store displays. Ask students what types of displays catch their attention.
- Discuss designing display racks.
- Show slides of effective and ineffective displays.
- Visit local greenhouses to observe different types of displays used.
- Have students complete Activity Sheet 1.

Objectives 3 and 4

- Discuss greeting customers. Ask students how they like to be greeted.
- Discuss conducting a sale.

Objectives 5 and 6

- Discuss sales transactions.
- Discuss packaging customer orders.
- Have a salesperson speak to the class about customer relations.

Objective 7

- Discuss how to handle customer complaints and returns. Ask students for examples of complaints about stores they have had and how they were dealt with.
- Have students complete Activity Sheet 2.

EVALUATION

Written Test

- Explain to students that they will be asked to demonstrate on the written test actions listed in the specific objectives.
- Give written test.

  NOTE: Written test may be given in sections if desired.

- Evaluate students on assignment sheet activities if not previously done.
- Reteach and retest if necessary.
- Complete appropriate section on competency profiles.
- Review individual and group performance in order to evaluate teaching methods. Adjust scope, sequence, or instructional approaches for additional lessons as required.

SUGGESTED RESOURCES

Audiovisual Materials

- *Customer Focused Selling*, Color, 1/2" VHS, Advantage Media, Inc., 1987. Available from Advantage Media, Inc., 21601 Marilla St., Chatsworth, CA 91311, 818-700-0504. This program introduces the five-step process involved in customer focused selling: the greeting, qualifying the customer, presenting the merchandise, overcoming objections, and closing the add-on sales.

- *Customer Service Selling*, Color 1/2" VHS, 16 minutes, Advantage Media, Inc., 1987. Available from Advantage Media, Inc., 21601 Marilla St., Chatsworth, CA 91311, 818-700-0504. This video emphasizes that the success of a retail company is entirely dependent on retail salespeople and the quality of customer service they provide. Salespeople can use it to analyze selling situations and to identify ways to increase sales. Greeting, discovering customer needs, presenting the merchandise, handling customer indecision, closing the sale and add-ons are five steps discussed.

NOTE: The above videos are available to Oklahoma teachers on a free-loan basis. Oklahoma teachers may order these videos from the Oklahoma Department of Vocational and Technical Education, Resource Center, ATTN: Instructional Media Specialist, 1500 West Seventh Avenue, Stillwater, OK 74074-4364, 1-800-522-5810. Out-of-state teachers must order from the addresses listed with each video.

- *Basic Retail Selling Skills*, Color, 1/2" VHS, 26 minutes, American Media Incorporated. Available from American Media Incorporated, 1454 30th Street, West Des Moines, IA 50265, 1-800-262-2557. The narrator takes a step-by-step approach to describing the key points of selling in a retail setting. Contains three parts: appearance, talking to the customer, and closing the sale.

- *Selling Edge*, Color, 1/2" VHS, 40 minutes, Dyna-Com Resources Inc. Available from Dyna-Com Resources Inc., 8120 West Baker Avenue, Lakewood, CO 80227, 1-303-986-9144. This is a retail-specific sales skills development program. Topics include: Introduction and Approach, Recognizing Wants and Needs, Features and Benefits, Suggestions Selling, Closing, Putting It All Together.

- *Take Care*, Color, 1/2" VHS, American Media Incorporated. Available from American Media Incorporated, 1454 30th Street, West Des Moines, IA 50265, 1-800-262-2557. This program teaches the techniques that create satisfied customers *who will return*. Key training points are: How to implement excellent customer relations; how to find out your customer's wants and needs; how to handle irate customers; how to have better telephone customer relations; and how to get organized.

Publications

- IDECC Marketing Education LAPs:
  - DE3034 Handling Customer Complaints
  - DE3035 Closing Sales

  NOTE: These materials are available to Oklahoma teachers from the Curriculum and Instructional Materials Center, Oklahoma Department of Vocational and Technical Education, 1500 W. Seventh Avenue, Stillwater, Oklahoma 74074. O[illegible]ma teachers may call toll free 1-800-522-5[illegible] ext. 589.

- Berninger, Louis, *Profitable Garden Center Management*, 2nd ed., Reston Publishing Co., Reston, Virginia, 1982.
- *Introduction to Agriculture Sales and Service*, Curriculum and Instructional Materials Center, Oklahoma Department of Vocational and Technical Education, Stillwater, Oklahoma, 1990.

UNIT REFERENCES

- Berninger, Louis, *Profitable Garden Center Management*, 2nd ed., Reston Publishing Co., Reston, Virginia, 1982.
- Bolen, William H., *Creative Selling: The Competitive Edge*, U.S. Small Business Administration, Washington, DC, n.d.
- Fisher, Dennis U., *Fundamentals of Business*, Mississippi State University, 1985.
- Hayett, William, *Display and Exhibition Handbook*, Reinhold Publishing Company, New York, New York, 1967.
- Pegler, Martin M., *Visual Merchandising and Display*, Fairchild Publications, New York, New York, 1983.
- Ralson, Trudy and Eric Foster, *How to Display It*, Art Direction Book Co., New York, New York, 1985.

- Stone, Ken and Angela Walker, *Caring for Customers is Your Business*, Cooperative Extension Service, Iowa State University, Ames, Iowa, 1985.
- U.S. Small Business Administration, *Increasing Your Selling Power*, Small Business Administration, Washington, DC, n.d.
- U.S. Small Business Administration, *Small Business Management Training Instructors Guide*, Small Business Administration, Washington, DC, 1984.

BASIC ACADEMIC SKILLS

The following table identifies the basic academic skills that are reinforced in this unit of instruction. These basic academic skills were identified using *The Basic/Essential Skills Taxonomy*, 2nd edition, and verified during the validation process.

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 1	Language Arts 098	Composes/ Edits	Reports/ essays	Summaries
	Science 124	Describes/ Explains	Color	
OBJECTIVE 2	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity
OBJECTIVE 3	Language Arts 132	Comprehends	Information-written	
	Language Arts 038	Collects/ Organizes	Information-oral/written	
OBJECTIVE 4	Language Arts 098	Composes/ Edits	Reports/ essays	Summaries
	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
OBJECTIVE 5	Language Arts 139	Comprehends	Information-written	Context

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 6	Language Arts 098	Composes/ Edits	Reports/ essays	Summaries
	Mathematics 229	Solves problems	Generate conclusions	Deductive reasoning
OBJECTIVE 7	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity
OBJECTIVE 8	Mathematics 229	Solves problems	Generate conclusions	Deductive reasoning
	Language Arts 146	Comprehends	Information-written	Rationale
	Language Arts 184	Evaluates	Information-written	Conclusions/ solutions
	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying

INFORMATION SHEET — CUSTOMER RELATIONS — XI

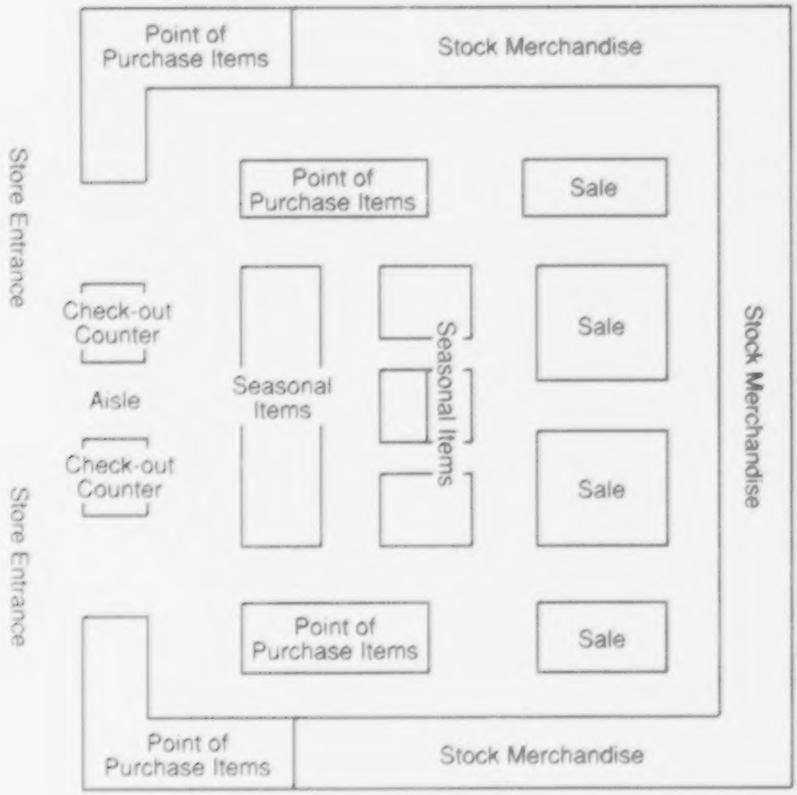
OBJECTIVE 1 **Discuss arranging store displays.**

Displays should capture the attention of people passing by and draw them into your business. The goal of a display is to catch the customers' eye, inform them what the product looks like, and show them how the product can be used.

- Outdoor displays such as flower beds, planter boxes or hanging baskets catch the consumer's eye and draw them into the greenhouse.
  - Banners, flags and awnings also make good outdoor displays.
  - Outdoor displays inform the consumer on the use of plants and what the plants will look like when used in the landscape.
  - Change the display often. Consumers quickly ignore displays if they remain the same for a long period of time.
  - Seasonal display beds encourage customers to plant bulbs and fall mums as well as summer annuals; this lengthens your selling season.
  - All displays must be well cared for and attractive. A poor outdoor display is worse than no display at all.
  - Use bright colors in outdoor displays; yellow, white and red are more noticeable than purple and blue.
- Window displays should be eye catching and have enough open space to allow customers to see inside the business.
  - These displays should be changed frequently; at least once a month.
  - Lighting can be used to spotlight the display at night.
  - Make sure the plants and props will hold up under intense heat and sunlight. Quickly replace any unattractive item.
  - Create displays that send messages to your customers; what do you want to tell your customers?

- Props are very useful in displays.
  - Props are items used in displays that are not for sale at your business.

    EXAMPLES: Bales of hay and pumpkins used in a fall outdoor display are props—you are not selling hay and pumpkins.
  - Fabric, balloons, wood and fountains are just a few props that can be used to set up greenhouse displays.
- Interior displays should create a specific traffic pattern inside the business. Customers follow established patterns.
  - Place seasonal displays near the front of the store. These up-to-date products will draw the customer into the store.
  - Heavy demand items should be placed in the back of the store. This requires the customer to walk through the greenhouse, and on their way they will see all the other merchandise you have for sale. *Customers buy what they see, not what they don't see.*
  - Merchandise should be displayed with self service in mind. A customer is more likely to purchase if they can pick up and examine the product.
  - Items near eye level will sell better than merchandise displayed near the floor or above eye level.
  - Rotate merchandise on shelves every few weeks. The customer will think a new shipment of products has been received.
  - Keep display shelves full. Customers think empty shelves mean "going out of business."
  - It is better to have a small display area that is well stocked than a large area partially stocked. Increasing display area does not always increase sales.


Point of Purchase Items
Stock Merchandise
Store Entrance
Point of Purchase Items
Sale
Check-out Counter
Seasonal Items
Seasonal Items
Sale
Stock Merchandise
Aisle
Check-out Counter
Sale
Store Entrance
Point of Purchase Items
Sale
Point of Purchase Items
Stock Merchandise

- Signs should be used to identify departments; chemicals, bulbs, seeds, herbs, etc.
  - Make sure signs provoke a positive feeling. "No cash refunds except for defective merchandise" should be presented as "Cash refunds on defective merchandise."
  - Contrast should exist between the background and letters on a sign. Black on white, white on black, and black on yellow are commonly used color combinations. Use caution with metallic or glitter paints; they can be difficult to read when the sun shines on them.
  - Many companies offer colorful posters that make attractive displays. Place them near the products they promote to help the customer with their purchase. Posters that show common garden insects and suggested control methods should be displayed in the chemical department.

- Handmade signs should be neat, clean and easy to read. Letters can be applied using rub on, stenciling or stick on methods.

- Display panels made from pegboard and hooks are very useful for beginners. These panels can be changed as frequently as desired.

- Point of purchase displays are set up near the cash register.

  - Impulse items such as gardening magazines and small tools are commonly located in this display.

- "Found space" displays are created wherever space can be found. Tools hanging on a wall or hanging baskets over flats of bedding plants are examples of a "found space" display.

  - Make sure the customer can easily see and examine the merchandise on a found space display.

  - Consider if the found space display will harm any displays below.

- All displays should be clean and neat. Make sure they are continually restocked as items are removed.

- Tie displays in with holidays or familiar symbols; fall, spring, Easter, Mother's Day.

- Every display should let the customer see the product from its best angle; an impatien hanging basket should be displayed above eye level so the flowers will be seen cascading over the pot edge, but a ground cover should be displayed low so the foliage will appear full and attractive.

- Color should be considered when setting up a display. Three different shades of red geraniums displayed side by side will not be attractive; the colors clash. But, if a group of white geraniums is placed between each red cultivar the display will be more pleasing.

- Observe displays at other businesses and learn how you could better display your merchandise.

- The final goal of any display is to show the customer what the merchandise will look like, or what it can do for the customer.

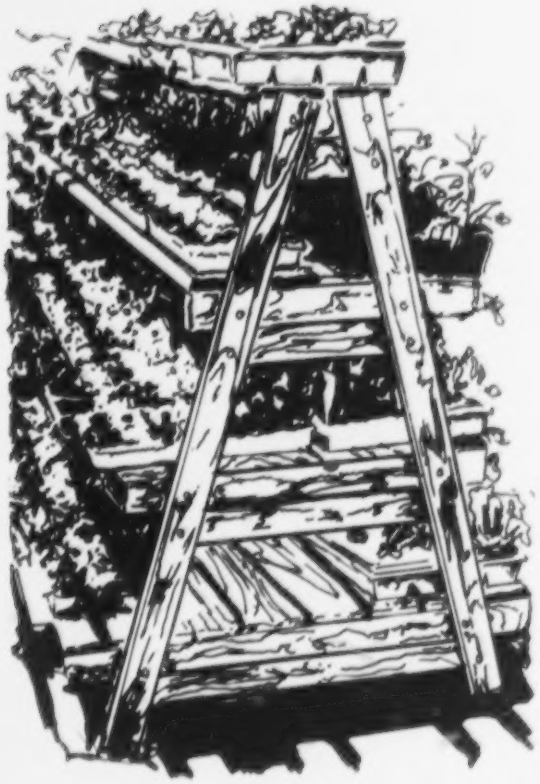
OBJECTIVE 2

Select from a list true statements about designing display racks. (Activity Sheet 1)

Most greenhouse display racks are designed and built by greenhouse personnel. Any design can be used as long as the merchandise is clearly visible and easily accessible to the customer.

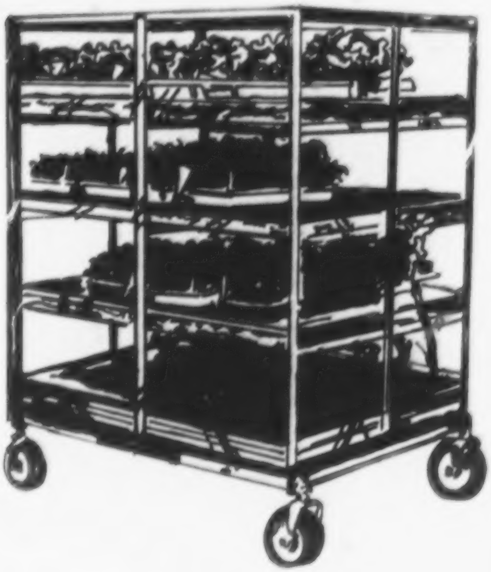
- Shelves are generally used for indoor display of permanent type products such as chemicals, fertilizers and pots.
  - Shelves can be metal units that are adjustable or homemade wooden units.
  - Shelves must be stable and easy to clean. Make sure they are strong enough to support the products they will display.
  - Shelves should be no lower than six inches above the floor or any taller than five and a half feet. Remember, customers buy what they see.
- Tables or benches are most commonly used to display plants. The table should allow the customer to easily see the merchandise.
  - An ideal height for display tables is 24-30 inches above the ground. Customers get a good view of the plants and they are easy to reach.
  - Customers do not like to bend down to browse.
  - Table display units allow plants to receive plenty of sunlight since there is only one layer of plants.
  - Wood is usually used to construct this type of display unit. When designing a unit, keep in mind how far a customer can reach.

- Tiered shelves are used to display several layers of plants in a small area.
  - An inverted V design is commonly used.



  - This design lets customers see all the plants and allows sunlight to enter.

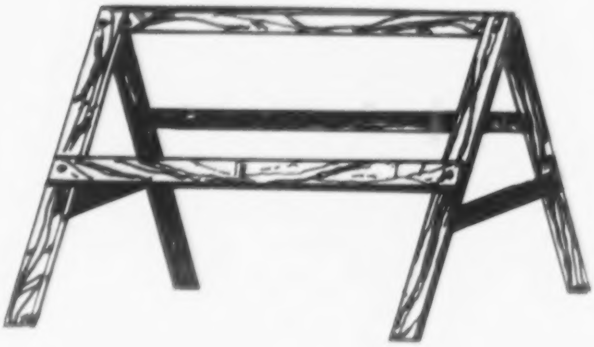
- Carts are preferred by some growers because plants can quickly be moved in and out of the greenhouse.
  - These units usually have numerous shelves, one above the other.
  - Plants cannot get sunlight and plant quality quickly declines.
  - Customers have a hard time seeing the plants because they are packed closely together and are located in the center of the cart.



- Suspended metal pipe is often used to attractively display hanging baskets in the greenhouse.
  - The pipe should be placed at the side or end of the greenhouse where the baskets won't be exposed to damage from people walking by.

- Make sure the pipe ends are covered so a customer is not injured.
- The pipe must be strong enough to hold the baskets and the greenhouse frame must be able to support the extra weight load.

- A-frame racks can also be used to display hanging baskets.



- Customers can easily see the baskets from both sides.
- This display unit is more space efficient than a suspended pipe.

- Displaying plants on the ground is not suggested.

- Customers will not bend down to browse and sales will be reduced.
- Plants may root to the ground and could be damaged when purchased.
- Ground level displays are unattractive and difficult to keep neatly stocked.

- Display units can be permanent structures that are painted and maintained yearly or they may be 1" x 4" boards laying on top of concrete blocks for temporary use.
  - Use the materials and resources available to design display units that fit your greenhouse needs.
- Key requirements for any display unit are:
  - Stability
  - Strength
  - Comfortable height
  - Customer accessible

OBJECTIVE 3 **Discuss greeting customers.**

Customers view a salesperson as the business. If they get a bad impression of a salesperson they usually won't buy from that business. Greeting customers in a small business is especially important. Customers expect more individualized treatment from a small business.

- Initial contact determines the impression a customer will have of the business.
- Greet the customer in a personal and friendly manner; treat them as an individual.
  - Smile and let the customer know you're glad they came.
  - Use statements like

    "Hi, I'm Sandy and if you have any questions I'll be glad to help."

    "Hello, nice to see you."
- If the salesperson is busy when a customer enters the greenhouse, let them know someone will be with them as soon as possible.
- Initial contact and greeting of a customer does a lot to create a positive image of the business and encourages sales.

OBJECTIVE 4

Discuss conducting a sale. (Supplement 1)

The contact that a customer has with a salesperson reflects the image of the greenhouse. Salespeople must be knowledgeable, helpful and friendly for customers to enjoy shopping at your greenhouse. If salespeople follow some basic guidelines it will lead to more satisfied customers and in return more sales.

- Use salespeople who are knowledgeable about the products and services the greenhouse sells. Salespeople have to be trained.
  - Salespeople should know the names of plants sold at the greenhouse. They should also know the cultural requirements for each plant. A customer will not have confidence in the salesperson if they cannot tell the customer whether the plant needs sun or shade.
  - Poorly trained employees give the customer a bad impression of the business.
  - Train the salespeople on how to use the cash register and any other equipment they might need to use. A person unfamiliar with machinery only frustrates customers.
  - Salespeople should be aware of the service policy and plant guarantees offered by the greenhouse.
  - Management must educate salespeople; they won't learn on their own!
- Greet the customer in a pleasant manner.
- Listen to what the customer says.
  - Carefully listen to what a customer says and then ask for more information. If a customer says they want some plants that will grow in shade, the salesperson should ask if they want foliage or blooming plants; what size of plants they want; is the area wet or dry? Get the customer involved in the sale.
- Present the merchandise effectively.
  - Suggest to the customer what products will work in their situation.

  - Explain the features and benefits of the item; "This plant grows in shady locations and it also blooms" or "this plant will grow in shady locations and it comes back year after year." Growing in a shady location is the item's feature and the benefit is that it blooms or comes back year after year.

  - Sell the benefits of a product. Customers feel like benefits are extra reasons why a product should be purchased.

  - Try to limit the customer's selection to three choices at a time; chances of a sale decrease if more than three choices are offered at one time.

- Handle any objections a customer may have to the sale.

  - Questions and objections are part of a sale. If a customer has some objections, they are interested in the product. If the customer says "but this plant cost three times more than that one;" you can explain to them that this plant is a perennial and will live for many years but the other plant only lives for one season and then must be replanted. The customer will save time and money because the plants will not have to be replaced every year.

- Close the sale by encouraging the person to purchase.

  - Offer a service that requires a simple yes or no response.

    "Would you like me to carry these plants to the cash register?"
    "Can I take the mulch out to your car?"
    "Would you like me to put these plants in a box?"

  - Inform them of important information.

    "This is the last shipment of geraniums we'll be getting."
    "These are all the marigolds we have left."
    "These plants perform great in our climate."
    "This plant will flower all summer long despite the heat."

- Suggest related products that might be needed.
  - This may cause the consumer to purchase items they were not intending to but could use.

    "Do you need any mulch for those geraniums?"
    "Do you have tomato cages for your plants?"
    "Do you need fertilizer for these houseplants?"
- Follow up the sale.
  - Let the customer know you appreciate their business; be sincere and creative. Use statements like:

    "Thanks for coming to our greenhouse."
    "Enjoy the geraniums!"
    "Let us know if you have any problems."
    "Thanks, come and see us again."

OBJECTIVE 5 **Complete statements about sales transactions.**

A sale should not be considered complete until the customer leaves the business satisfied with their purchase. Customers are more likely to return to the business if they are satisfied with their purchase.

- Customer satisfaction is a requirement for every sale.
  - Make sure the customer got the product they wanted and needed. If they didn't they will be unhappy later.
  - Make sure the customer knows how to use, or care for, the product.
- Cashiers should promptly and courteously total the customer's order.
  - If checks are written they should pleasantly ask for the required information.
  - Discuss any questions the customer may have about prices in a friendly manner.

- Ask if assistance is needed to get their purchases loaded in the vehicle.
    - Quickly call a delivery person for assistance when needed.
- Always thank the customer for shopping at the greenhouse.
    - Pleasant experiences and helpful salespeople will guarantee a repeat customer.

OBJECTIVE 6

Discuss packaging customer orders.

A greenhouse must do everything possible to make sure the customer's items get home in a safe manner.

- Packaging will depend on the item bought and the time of year.
- Cold weather requires that all plants be protected.
    - Sleeves should be used on any large plant and the top should be stapled shut.
    - Smaller plants can be placed in a sack and the bag stapled shut.
    - Explain to the customer that the plants cannot be left in the car, even for a short period of time.
    - Sleeves should be cut off the plants when they arrive at the final destination.
- Warm weather reduces the need for packaging.
    - Some customers will prefer sleeves because they protect the plants and make them easier to carry, and other customers may not want any type of packaging.
    - Bedding plants are usually packaged in shallow cardboard flats. These flats hold the plants upright and let the customer carry many plants at one time.
- Miscellaneous supplies such as chemicals, seeds, tools, books, etc. should be placed in a bag unless the customer says otherwise.
    - Large bags of peat, bark, soil etc. will usually be laid in the customer's vehicle.

OBJECTIVE 7 **Select from a list true statements about how to handle customer complaints and returns.** (Activity Sheet 2)

Everyone has purchased a product that did not work as it should have or was in some way unsatisfactory. The customer feels they've been treated unfairly and would like the problem to be corrected. Greenhouse customers are no different.

- The goal in dealing with complaints and returns is to make the customer happy.
  - If customers are unhappy with a product they will be less likely to return to the business.
  - Unhappy customers will tell other people about the problem they had at your greenhouse. This is not the kind of advertisement you want for your business.
- The formula for dealing with complaints and returns is:

  L listen
  E empathize
  A ask questions about the situation
  R respond positively, tell what you are going to do

- Listen closely to what the customer has to say.
  - Often they will be angry and irate. This anger is not aimed at you personally!
- Empathize with the customer about their trouble.
  - Say things like:

    "I know how frustrating this is."

    "I understand how aggravating this must be."
  - Empathetic statements usually help calm the customer down.
- Ask questions about the problem.
  - This lets the customer blow off steam and it provides information about the trouble.
  - Remember, keep calm and stay rational. The customer is not mad at you personally.
  - Keep asking questions and talking about the problem until you determine the cause and decide upon a solution.

- Respond positively to the situation.
  - Explain what you are going to do to correct the problem.
  - Replacement items are usually offered; cash is given if the customer has a receipt and will not accept a replacement item.
  - Ask the customer if the planned solution is satisfactory with them. Get them to agree on your solution.
  - After corrections have been made, reiterate that you appreciate their business and you're sorry about the inconvenience.
- Every greenhouse business determines their own policy on returns, refunds and guarantees.
  - Some businesses feel they must offer full guarantees to compete with mass markets; other greenhouses feel they cannot afford to offer a guarantee.
  - $6.00 lost today replacing 3 geraniums might mean a repeat customer who spends $25.00 next spring.
- Never blame a customer outright for plant loss. Explain to them the correct way to care for the plant. Make sure when you give them replacement plants that they know how to care for them.
- The secret to customer relations is sincerely caring about helping people.

SKILLS NEEDED TO BE A SUCCESSFUL SALESPERSON

- Effective salespeople must have the personal and technical skills to use the creative selling process.
- **Personal skills** required are:
  - Clean personal hygiene and good grooming. No customer wants to spend time with a salesperson who is not well groomed.
  - Common sense and good judgment skills. A salesperson never argues with a customer, tells the customer they are wrong, or reveals problems at the business.
  - Tact. They must talk with the customer in a polite and respectful manner.
  - Positive attitude. They should be willing to learn and work hard. Bad attitudes create employee problems and cause disruption.
  - Good listener. Many people listen but few hear what the customer says.
- **Technical skills** required are:
  - Communication skills. The salesperson must be able to talk with a customer in an educated and intelligent manner.
  - Writing abilities. Invoices must be written; customers will ask for names, references or chemicals and the salesperson must be able to help the customer.
  - Time management. The salesperson must understand how to help the customer in a timely manner; some customers will talk to the seller all day if given the chance.
  - Telephone skills. A pleasant voice and courteous manner are required to sell the business over the telephone.
- A good salesperson helps one customer at a time!

DISPLAY IDEAS

1. Displays often center around themes. These themes include seasons (fall) as well as holidays (Christmas) and other events (homecoming). Write down as many different themes as you can think of and then compare them with other students' themes.

Seasons	Holidays	Other Events

2. Pick one theme from question 1 and develop a display idea around this theme. Decide on the type of display (outdoor, window, etc.), the props you will use, the color scheme, any plants or flowers you will use in the display, etc. Write down your ideas and draw a rough sketch of your display.

INTERACT WITH CUSTOMERS

INTRODUCTION

Greenhouse personnel must be able to interact with customers and handle a variety of situations on a daily basis. The ability to be courteous and friendly is important.

Three situations are given. Choose one or more of the situations for this activity.

- Pair off with a partner.
- Decide who will play the customer and the greenhouse employee.
- Students should play both roles.
- Using the customer relations and sales techniques you've learned in this unit, act out the scenario in front of the class.
- Have your classmates offer comments on how you handled the situation.

Situations

1. Mr./Ms. Hadsworth comes into the greenhouse upset because the hibiscus he/she purchased several weeks ago has died.
2. Mr./Ms. Hadley comes into the greenhouse wanting to purchase several plants. He/She does not know exactly what type of plants to purchase.
3. Mr./Ms. Thompson comes into the greenhouse and needs help in purchasing flowers for a reception.

ASSIGNMENT SHEET 1

CUSTOMER RELATIONS

XI

NAME ______________________ SCORE ______

OBJECTIVE 8

Analyze customer relations situations.

INTRODUCTION

The ability to interact with customers is essential if a business is to be successful. An incident that may seem minor to a salesperson could cause a customer to stop coming to that business. Treat all customers with courtesy.

DIRECTIONS

Analyze the situations given and determine what the salesperson did wrong. Write your answers in the space provided.

1. Mr. Tomlin comes into the greenhouse and explains that it appears that one of his plants has a disease. He is not sure what it is. The salesperson directs Mr. Tomlin to the section of the greenhouse which has pesticides.

2. Ms. Roberts comes into the greenhouse. The salesperson is busy and ignores Ms. Roberts. The salesperson is planning on greeting her but wants to finish a phone call first.

3. Mr. Lany purchases two 50 pound bags of fertilizer. The salesperson thanks Mr. Lany for shopping at the greenhouse and proceeds to help another customer.

4. Mr. Gabel comes into the greenhouse upset and explains that a plant he purchased several weeks ago died. The salesperson assumes that Mr. Gabel did not properly take care of the plant and states that to him.

5. Ms. Humphrey purchases several small items. The salesperson assumes she can carry them to her car and does not put them in a sack.

CUSTOMER RELATIONS

ASSIGNMENT SHEET 1

1. The salesperson should have asked Mr. Tomlin questions about his plant to determine the problem. Then the salesperson would be better informed and could recommend treatment for the plant.
2. The salesperson should greet every customer. The salesperson should have asked the person on the phone to hold and told Ms. Roberts someone would be with her in a moment.
3. The salesperson should have asked Mr. Lany if he needed any help carrying the bags to his car.
4. The salesperson should not have blamed Mr. Gabel for the plants dying.
5. The salesperson should have put the items in a sack or box.

WRITTEN TEST

CUSTOMER RELATIONS

XI

NAME ______________________ SCORE ________

OBJECTIVE 1

Discuss arranging store displays.

1. Name two kinds of outdoor displays a greenhouse could use.

2. When setting up interior displays where should the heavy demand items be located and why?

3. What is a point of purchase display?

OBJECTIVE 2

Select from a list true statements about designing display racks. Write an "X" in the blank before each true statement.

____ 1. Carts are the best way to display plants for sale because they can be rolled indoors at night.

____ 2. A-frame racks can be built to neatly display hanging baskets.

____ 3. Setting bedding plants on the ground is a good way to display plants because the customer sees what they will look like once they are planted.

____ 4. Lots of growers suspend a pipe from the greenhouse frame to display hanging baskets.

____ 5. When hanging baskets on a suspended pipe make sure the greenhouse frame and pipe are strong enough to support the weight.

____ 6. Display units should be considered permanent structures.

____ 7. Tables used as display units should be at least 24 inches above the ground.

____ 8. The highest display shelf should be five and a half feet above the ground.

____ 9. Tiered shelves let customers easily see all the merchandise and they also let sunlight reach the plants.

OBJECTIVE 3

Discuss greeting customers. Briefly discuss how customers should be greeted when entering a greenhouse.

OBJECTIVE 4 **Discuss conducting a sale.**

1. Discuss presenting merchandise effectively.

2. Why is it important to have trained salespeople?

3. A customer asks for help selecting a pesticide to control aphids. Describe how you would conduct the sale.

OBJECTIVE 5 **Complete statements about sales transactions.** Write the missing word in each blank.

1. A pleasant experience at the greenhouse will guarantee a __________ customer.
2. A customer should always be __________ for shopping at the greenhouse.
3. A salesperson should make sure the customer understands how to __________ for the plants they've purchased.
4. Cashiers should always ask the customer if they need __________ loading their purchases.

OBJECTIVE 6 **Discuss packaging customer orders.**

1. How would you package three 6" poinsettias a customer purchased in December?

2. How would you package an order that has three cell packs of vinca, two 4 1/2" geraniums and four 3" coleus?

OBJECTIVE 7

Select from a list true statements about how to handle customer complaints and returns. Write an "X" in the blank before each true statement.

____ 1. Unhappy customers will tell other people about the bad experience they had at your greenhouse.

____ 2. The goal of handling complaints and returns is to make the customer happy.

____ 3. A greenhouse's reputation is built alone on the quality of the products they sell.

____ 4. Most customers are angry when they have complaints and the sales person should argue back because it helps the customer release their anger.

____ 5. Listen to what a customer says so you'll understand what the problem is.

____ 6. Customer anger is usually directed personally at the salesperson.

____ 7. Empathize with the customer and help them calm down.

____ 8. Ask questions about the problem until you have found the cause of the trouble.

____ 9. Tell the customer what you're going to do to correct the situation, and ask them if they agree with your solution.

____ 10. Offer cash refunds unless the customer requests a replacement item.

____ 11. Always thank the customer for shopping at the greenhouse and apologize for the inconvenience of having to return a product.

____ 12. A replacement item should not be given if the customer does not have their sales receipt.

____ 13. The secret to customer relations is sincerely caring about helping people.

NOTICE

The following assignment sheet is not part of the written test. If this activity has not been completed, check with your instructor.

OBJECTIVE 8

Analyze customer relations situations. SCORE ________

OBJECTIVE 1

1. Answer should include any two of the following:
   - Flower beds.
   - Planter boxes.
   - Hanging baskets.
   - Flags, banners, awnings.
2. In the back of the business so the customer will have to walk through the entire store; they will see all the merchandise you have.
3. A display of impulse items near the cash register.

OBJECTIVE 2

2, 4, 5, 7, 8, 9

OBJECTIVE 3

Answer should include the following key points.

- Smile when the customer enters.
- Always acknowledge a customer even if you are busy.

OBJECTIVE 4

1. Explain the features and benefits of the item. Sell the benefits of the product. Try to limit the customer's selection to three choices at a time.
2. So customers will have confidence in the salesperson and think that the greenhouse is well prepared and organized. So correct information will be given to customers and they will have success with their purchases.

3. Answer should include the following points:

   - Show them where the chemical department is.
   - Ask what crop the chemical is for.
   - Ask if the want a powder or liquid chemical.
   - Tell them about features and benefits of each chemical.
   - Discuss any objections they may have.
   - Close sale by suggesting a chemical.
   - Ask if they need a sprayer, gloves, goggles etc.
   - Follow up by telling them thanks.

OBJECTIVE 5

1. repeat
2. thanked
3. care
4. help

OBJECTIVE 6

1. Sleeve the plants.

   Staple the top shut.

   Tell customer not to leave the plants in the carand to cut the sleeve off when they get the plants home.
2. Set them in a cardboard flat.

OBJECTIVE 7

1, 2, 5, 7, 8, 9, 11, 13

OBJECTIVE 8

Refer to answers to Assignment Sheet 1.

OBJECTIVE SHEET

PERFORMING GENERAL OFFICE WORK

XII

INTRODUCTION

Office work is of major importance to all businesses. A filing system is required to ensure that bills are paid promptly and invoices are sent to credit customers. These records are also required for tax purposes and are valuable when ordering supplies. Financial records track money deposited into the greenhouse account. In addition, the necessary office supplies and equipment must be stocked and maintained.

UNIT OBJECTIVE

After completing this unit, the student should be able to develop office procedures that will maintain records for all business transactions and keep the greenhouse office running smoothly. The student will demonstrate these competencies by completing the assignment sheets and written test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Select from a list true statements about arranging a filing system.
2. Select from a list true statements about office supplies and equipment.
3. Discuss the proper procedures for handling telephone calls.
4. Discuss mail handling procedures.
5. Complete statements about maintaining a mailing list.
6. Select from a list true statements about preparing a bank deposit.
7. Arrange in order the steps in reconciling a bank statement.
8. Designate the correct filing order. (Assignment Sheet 1)
9. Fill out a deposit slip. (Assignment Sheet 2)
10. Reconcile a bank statement. (Assignment Sheet 3)

PERFORMING GENERAL OFFICE WORK

PREPARATION

- Obtain materials to supplement unit.

  NOTE: See Suggested Resources.

- Review instructional outline for this unit. Modify time frames to suit class needs and plan activities for each class period.

- Study the specific objectives to determine those you will cover in your presentation. Decide also which objectives should be taught to which students.

- Determine scope and sequence of objectives that you add. Design and develop support materials, including evaluation techniques, for additional objectives.

- Determine how you will schedule time for students to demonstrate competence in the required procedures.

- Make arrangements for guest speakers. Supply speakers with specific objectives and other appropriate sections of the unit.

DELIVERY

Objectives 1 through 3

- Introduce the topic of performing general office work. Emphasize that this is a necessary part of operating a successful business.

- Discuss arranging a filing system.

- Discuss supplies and equipment. Have students make a list of what they consider to be common office supplies and equipment.

- Discuss proper procedures for handling telephone calls.

- Have an office manager speak to the class on performing general office work.

Objectives 4 and 5

- Discuss mail handling procedures.
- Discuss maintaining a mailing list.

Objectives 6 and 7

- Discuss preparing a bank deposit.
- Discuss reconciling a bank statement.

APPLICATION

Objective 8

- Use Assignment Sheet 1 to help students learn how to develop a filing system.

Objective 9

- Use Assignment Sheet 2 to give students practice in preparing deposit slips.

Objective 10

- Use Assignment Sheet 3 to give students practice in reconciling bank statements.

EVALUATION

Written Test

- Explain to students that they will be asked to demonstrate on the written test actions listed in the specific objectives.
- Give written test.

  NOTE: Written test may be given in sections if desired.
- Evaluate students on assignment sheet activities if not previously done.
- Reteach and retest if necessary.
- Complete appropriate section of competency profiles.
- Review individual and group performance in order to evaluate teaching methods. Adjust scope, sequence, or instructional approaches for additional lessons as required.

UNIT REFERENCES

- Cook, Fred S. and Lenore S. Forti, *The Dartnell Professional Secretaries Handbook*, The Dartnell Corporation, Chicago, Illinois, 1981.
- MacNeil, James, *Accounting Practices Management Handbook*, American Institute of Certified Public Accountants, New York, New York, 1962.
- Ragan, Robert C. and M. Zafar Iqbal, *Financial Recordkeeping for Small Stores*, U.S. Small Business Administration, Washington D.C., 1985.
- Stone, Ken and Angela Walker, *Caring for Customers is Your Business*, Cooperative Extension Service, Iowa State University, Ames, Iowa, 1985.

BASIC ACADEMIC SKILLS

The following table identifies the basic academic skills that are reinforced in this unit of instruction. These basic academic skills were identified using *The Basic/Essential Skills Taxonomy*, 2nd edition, and verified during the validation process.

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 1	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity
	Language Arts 146	Comprehends	Information-written	Sequence
OBJECTIVE 2	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity
	Language Arts 146	Comprehends	Information-written	Sequence
OBJECTIVE 3	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
OBJECTIVE 4	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
OBJECTIVE 5	Language Arts 252	Infers/ Predicts	Information-written	Context

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 6	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity
OBJECTIVE 7	Mathematics 254	Understands	Order of operation	Rules
OBJECTIVE 8	Language Arts 146	Comprehends	Information-written	Sequence
OBJECTIVE 9	Mathematics 254	Understands	Order of operation	Rules
	Mathematics 034	Computes	Addition	Whole numbers
	Mathematics 026	Computes	Addition	Decimals
	Mathematics 073	Computes	Multiplication	Whole numbers
	Mathematics 261	Uses calculator	Addition	
	Mathematics 266	Uses calculator	Multiplication	
	Language Arts 058	Composes/ Edits	Forms/ documents	

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 10	Mathematics 026	Computes	Addition	Decimals
	Mathematics 084	Computes	Subtraction	Decimals
	Mathematics 261	Uses calculator	Addition	
	Mathematics 268	Uses calculator	Subtraction	
	Mathematics 229	Solves problems	Generate conclusions	Deductive reasoning

INFORMATION SHEET

PERFORMING GENERAL OFFICE WORK

XII

OBJECTIVE 1

Select from a list true statements about arranging a filing system.

Every office needs an organized method of storing business records. These records will be needed for billing, ordering and tax purposes.

- A file cabinet is required to keep all the records together in an orderly fashion.
  - Cabinets can be purchased with one, two, or four drawers. The size of cabinet needed will depend on the amount of records the business has.
  - Cardboard boxes should not be used as file cabinets. These boxes are not durable and are difficult to use.
- Manila folders with index tabs should be used to hold records in each file.
  - Names should be clearly printed on the folder tabs.
  - Colored folders are available. Some offices use these folders to denote different types of files.

  EXAMPLE: Red folders are accounts that are on the south delivery route and green folders are on the north delivery route.
- Alphabetical order is the most common way of arranging files.
  - If the files are for persons, alphabetize using the last name. Ignore titles like Dr., Jr., Sr. and III when arranging files.
  - When two people have the same last name continue the alphabetizing process using the first name.
  - If the files are for businesses, alphabetize according to the company's name. Ignore the title "The" in a company name.

- A company name that begins with initials like AAA or ABC is filed before common names in that letter group. Names that are connected initials, like A & L or A.P. are filed between initials and common names.

  EXAMPLE: A correct filing order would be; AAA Greenhouse, A & M Flower Shop, Anderson Greenhouse.

- Place files in the filing cabinet with the A's in the front of the drawer and the Z's in the back of the drawer.

- Files can be divided into different groups and alphabetized within a group if desired. For example, wholesale customers may be in one group and retail customers in another group.

  - Usually a complete file drawer is used for each group.

- Place any invoices, bills or correspondence in the correct file for reference purposes.

  - Put current invoices or records on top of the older material already in a file. Then when a file is opened the newest material is readily visible.

- Filing should be done at least once a week.

  - Do not let records pile up for months and then try to file them. The records could be lost or ruined before they get filed.

- Files are usually put into permanent storage at the end of the fiscal year and new files are immediately started.

  - Files that are frequently used, or are small can be left in the office until they become too large.

  - Don't throw away any records until they are seven years old. The IRS can request records that are up to seven years old.

- Most greenhouses hire a person who primarily does office work.

  - They will answer the phone, file, send invoices, pay bills and handle general correspondence.

  - Small greenhouses may only need to hire an office person on a part time basis.

OBJECTIVE 2

Select from a list true statements about office supplies and equipment.

An efficient office must have the necessary materials and supplies on hand when needed. Equipment must be maintained and kept in working order.

- Typical office supplies include pens, pencils, paper, envelopes, folders, markers, stamps, tape, computer disks, staples, paper clips, etc.
- An extra box/package of each supply should be held in storage. When an item is removed from storage, immediately purchase a replacement for the storage area.
- Post a supply request sheet near where the supplies are kept. Employees who use the last of an item should write it on the request sheet so it can be purchased. Special request items can also be written on this sheet.
- Office supply companies will usually deliver free to the greenhouse if an order is placed by telephone. Talk with the salesperson to find out if there is a minimum order or delivery charge.
- Mass market and discount stores are generally less expensive but the greenhouse must send an employee to do the shopping.
- Quick inventories of supplies can be done at the end of every month. This helps eliminate running out of supplies.
- Common office equipment includes photocopiers, computers, printers, typewriters, postage meters, staplers, coffee machines, pop machines, etc.
- Office equipment should be insured.
- Equipment must be monitored for routine maintenance and repairs. Service technicians and repair personnel must be notified of equipment problems.
- Machines operate at peak performance if they are routinely cleaned and adjusted. Office personnel are usually responsible for this.
- Office equipment may also require supplies.

  EXAMPLES: Ink for photocopiers, coffee and cups for coffee machines, ribbons for typewriters

- Inventory these item at the same times office supplies are evaluated.

- Make a shopping list of needed items and then wait 1-2 days before ordering. This gives personnel time to think of other needed items.

- Hiring a person to be responsible for the office frees the grower/manager from these time consuming but important tasks. The office employee can also order greenhouse products and supplies for the grower.

OBJECTIVE 3

Discuss the proper procedures for handling telephone calls.

Much of today's business is done by telephone. It is a quick, easy and inexpensive way to get information or buy and sell a product. It is important that greenhouse employees present a positive and professional image over the telephone.

- Customers call the greenhouse to see if you have a specific product, to see how much something costs, or to solve a problem.

- Employees must greet the caller in a friendly and pleasant manner. The caller should feel the "smile" in the employee's voice.

- Procedure for telephone etiquette is:

    1. Answer the phone promptly. Excessive ringing creates a bad image and may irritate the caller.

    2. Speak clearly and put a smile into your voice. Do not mumble a memorized opening statement. By using good telephone skills employees give customers a good first impression of the business.

    3. Identify the business and the person speaking. Use opening statements such as the following:

        "Good afternoon, the Garden Gate, Debbie speaking."

        "The Garden Gate, this is Terry, may I help you?"

        "Thanks for calling the Garden Gate, this is Dave. May I help you?"

        "Merry Christmas from the Garden Gate, this is Jack. May I help you?"

4. Answer questions in an accurate and honest manner.

   If you have to check on a problem or question, tell the caller what you are going to do; do not just leave them hanging on the phone.

   If searching for the answer will only take a short period of time, ask them to hold. If it is going to take a few minutes, ask for their name and number and tell them you will return their call. Return calls as soon as possible!

5. If the greenhouse cannot help with the customer's problem, other possible options should be suggested. If the customer requests something the greenhouse does not sell, the employee should suggest other businesses where the items might be found.

   This type of conversation helps build a good relationship between you and the caller.

6. Always thank the person for calling your greenhouse and offer help or service in the future.

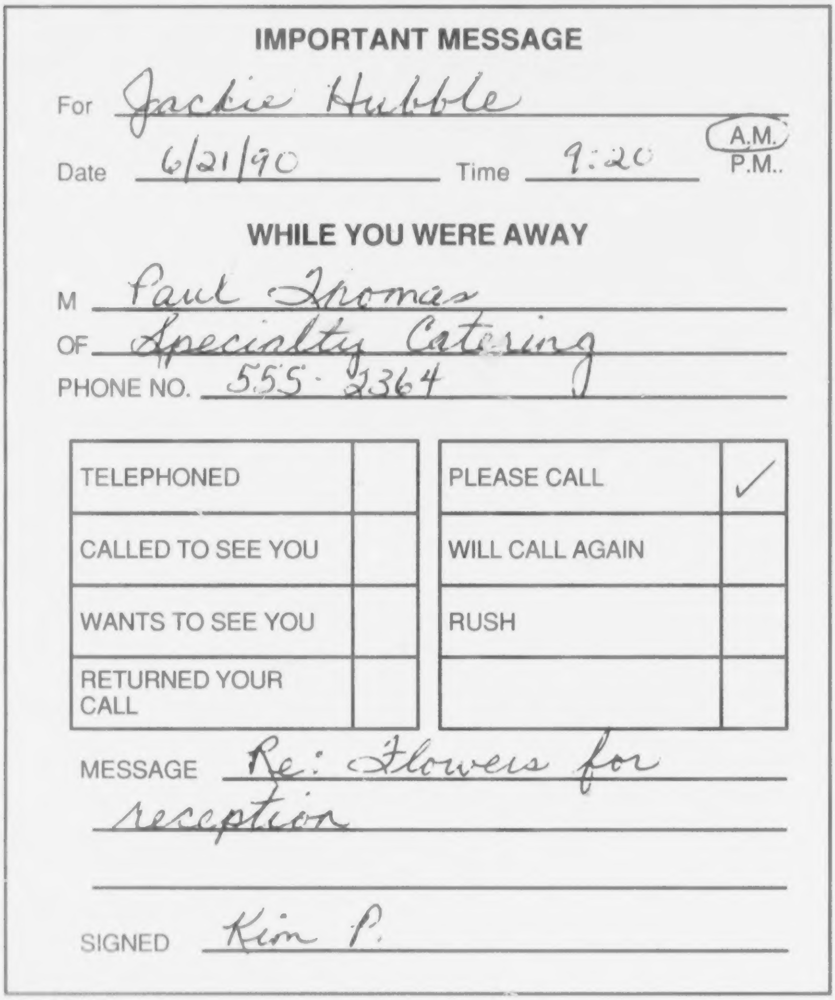
- Taking messages is a related part of many telephone calls.

  EXAMPLES: A call for an employee who is busy or is not scheduled to work that day, a call for the manager or grower when he or she is in a meeting, or a call from a customer with a question that the employee cannot answer

- Information on a message includes:

  - Name of person to receive the message
  - Date and time of call
  - Caller's company name
  - Caller's telephone number
  - Response requested

- Message pads are specifically designed for recording this kind of information.



IMPORTANT MESSAGE

For Jackie Hubble

Date 6/21/90 Time 9:20 [✓ A.M.] P.M..

WHILE YOU WERE AWAY

M Paul Thomas

OF Specialty Catering

PHONE NO. 555-2364

TELEPHONED		PLEASE CALL	✓
CALLED TO SEE YOU		WILL CALL AGAIN	
WANTS TO SEE YOU		RUSH	
RETURNED YOUR CALL			

MESSAGE Re: Flowers for reception

SIGNED Kim P.

- Designate an area where messages are to be left. All employees will know where to leave, and look for messages.
- Promptly handle any messages you receive. Callers will remember the courtesy of employees.

OBJECTIVE 4 **Discuss mail handling procedures.**

The sending and receiving of mail is critical to the smooth operation of the greenhouse.

- Invoices are sent to customers and checks are received through the mail.
- Bills which the greenhouse must pay come in the mail, and checks must be sent out.
- Without the prompt handling of the mail, the greenhouse management would not know if checks have been received from the customers or if the greenhouse bills have been paid.
- Mail is delivered daily and should be examined the day it arrives.
- Office personnel are usually responsible for handling the mail. If the greenhouse has no office personnel, the grower/manager must take care of the mail.
- Mail should be sorted as soon as it arrives so each employee receives his or her own personal mail. Many greenhouses have a small "mailbox" for each employee in the office.
- Mail addressed to the business should be opened promptly.
- Distribute the material to the correct location to be processed.
    - Checks that are received should be stamped for deposit, recorded as received, placed in the cash register, and deposited in the bank at the end of the day.
    - Invoices should be given to the person assigned to write checks for the greenhouse.
    - Letters requesting information should be passed along to the proper person.
    - Advertisements and junk mail should be looked at and filed if valuable, or should be quickly discarded.
- Outgoing mail should leave the greenhouse on a daily basis. The mail carrier usually has a routine delivery schedule and office personnel know when the mail must be ready for pickup.
    - Invoices that have been written need to be promptly sent to customers for payment.

  - Checks sent from the greenhouse must reach their destination quickly to avoid late payment charges.
  - Large packages or bulky envelopes must be taken to the post office to be weighed. Obtain a receipt from the post office when large packages are mailed.
- Mail should be processed promptly to avoid having it misplaced, forgotten, or stolen.

OBJECTIVE 5

Complete statements about maintaining a mailing list.

A mailing list is simply a list of all of the greenhouse's customers. A mailing list is an important part of any advertising or creative selling campaign.

- New information should be added to the existing mailing list once a week. One specific day should be set aside for updating the mailing list.
- New names should be added and inactive names removed.
- Any changes in names or addresses should be included in the update.
- Designate a file or box to hold all new data for the mailing list. Enter all changes once a week.

OBJECTIVE 6

Select from a list true statements about preparing a bank deposit.

- Checks and cash received at the greenhouse should be deposited in the bank at the end of each business day. It is not safe to keep money at the greenhouse.
- All checks must be endorsed before being deposited into the bank account. A rubber stamp may be used to save time in endorsing checks.

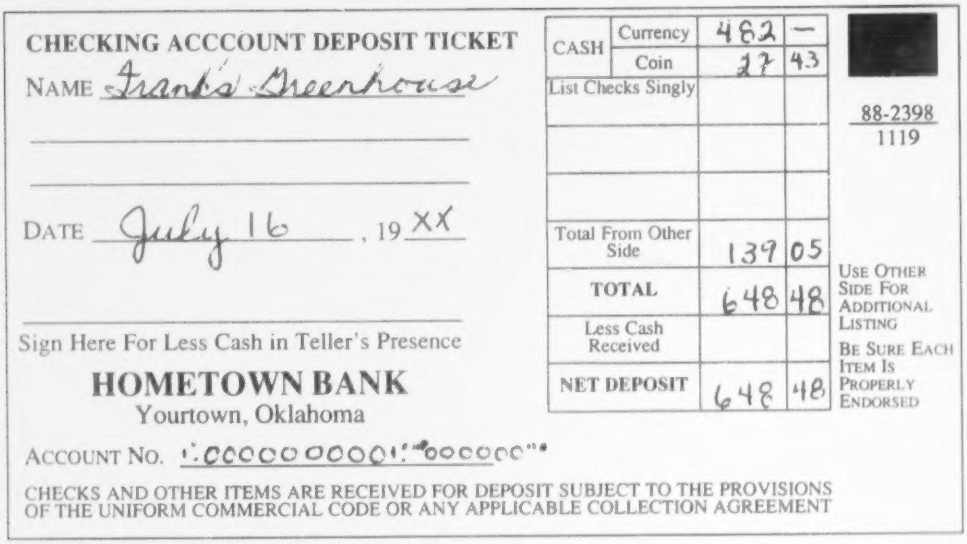
  The stamp should contain the following information:

  - Name of the greenhouse
  - "For deposit only"
  - Bank account number

- All checks should be stamped on the back as soon as they are received from the customer. This endorsement prevents the checks from being cashed.

- A deposit slip must accompany the money being deposited. The deposit slip provides the bank with the account number of the greenhouse. This assures that the money will be deposited into the correct account. The following steps should be taken when filling out a deposit slip.

  1. Fill in the date of the deposit.
  2. Using the lower back side of the deposit slip, record all currency.
  3. Add the amount of bills and record the total on the front of the deposit slip next to "currency."
  4. Count all coins and record the total next to "coin."
  5. If you have three checks or less, record them on the front of the deposit slip next to "checks."
  6. For more than three checks, use the back of the deposit slip to record them. Add the amount of the checks and record next to "Total."
  7. Record the total amount of the checks listed on the back of the deposit slip next to "Total from other side."
  8. Add all currency, coins and checks together and record the amount next to "Total."
  9. Usually no cash is received from a business deposit, so the section next to "Less cash received" is left blank.
  10. The line marked "Sign here for less cash in teller's presence" will probably not be used, it should be left blank.
  11. Record the total of the deposit again next to "Net deposit."



CHECKING ACCCOUNT DEPOSIT TICKET

NAME Frank's Greenhouse

DATE July 16, 19 XX

Sign Here For Less Cash in Teller's Presence

HOMETOWN BANK
Yourtown, Oklahoma

ACCOUNT NO. ⑆0000000001⑆000000⑈

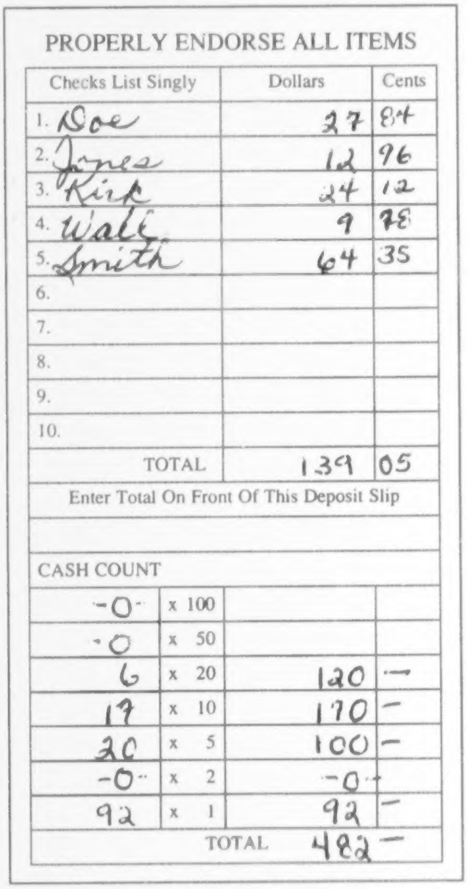
CASH	Currency	482	—
	Coin	27	43
List Checks Singly			
Total From Other Side		139	05
TOTAL		648	48
Less Cash Received			
NET DEPOSIT		648	48

88-2398
1119

USE OTHER SIDE FOR ADDITIONAL LISTING

BE SURE EACH ITEM IS PROPERLY ENDORSED

CHECKS AND OTHER ITEMS ARE RECEIVED FOR DEPOSIT SUBJECT TO THE PROVISIONS OF THE UNIFORM COMMERCIAL CODE OR ANY APPLICABLE COLLECTION AGREEMENT



PROPERLY ENDORSE ALL ITEMS

Checks List Singly		Dollars	Cents
1. Doe		27	84
2. Jones		12	96
3. Kirk		24	12
4. Wall		9	78
5. Smith		64	35
6.			
7.			
8.			
9.			
10.			
	TOTAL	139	05

Enter Total On Front Of This Deposit Slip

CASH COUNT

-0-	x 100		
-0-	x 50		
6	x 20	120	—
17	x 10	170	—
20	x 5	100	—
-0-	x 2	-0-	
92	x 1	92	—
	TOTAL	482	—

- Keep a copy of each deposit slip you fill out. If a customer's check is returned this will be the only way you have of finding out who's check it was. You can then contact that person and try to get your money from them.

- Banks provide commercial accounts with zippered money bags to use when making deposits. Place the monies and deposit slip in the bag and give it to the bank teller. If using the night deposit box, drop the bag in the slot.

- Record the amount of deposit in the checkbook register and in the proper journal account.

OBJECTIVE 7 **Arrange in order the steps in reconciling a bank statement.**

Each month the bank will send the greenhouse a statement of all deposits and withdrawals that were made on the greenhouse account during the month. This statement should be compared to the checkbook register and journal accounts to find any errors.

- Promptly reconcile your bank statement and checking account. Most banks have a limited time period for reporting errors. The front of a bank statement is shown on the following page.

HOMETOWN BANK

Yourtown, Oklahoma – 10008
(000) 555-5555

STATEMENT DATE	
CHECKING ACCT. #	

699 T
8 1
07 28
F 26

Any Student
200 Something Street
Yourtown, Oklahoma 10008
(000)555-5555

PAGE
1 OF 1

CHECKING ACCOUNT STATEMENT

Balance Last Statement	Total Amount of Checks Paid	No. of Checks Paid	No. of Deposits	Total Amount of Deposits Made	Service Charges	Balance This Statement

DATE	IDEN. NUMBER	TRANSACTION AMOUNT	BALANCE	TRANSACTION DESCRIPTION

↑
LAST AMOUNT IN THIS COLUMN IS YOUR BALANCE

PLEASE EXAMINE STATEMENT OF ACCOUNT AND VOUCHERS AT ONCE

IF NO ERROR IS REPORTED IN TEN DAYS THE ACCOUNT WILL BE CONSIDERED CORRECT

KEY

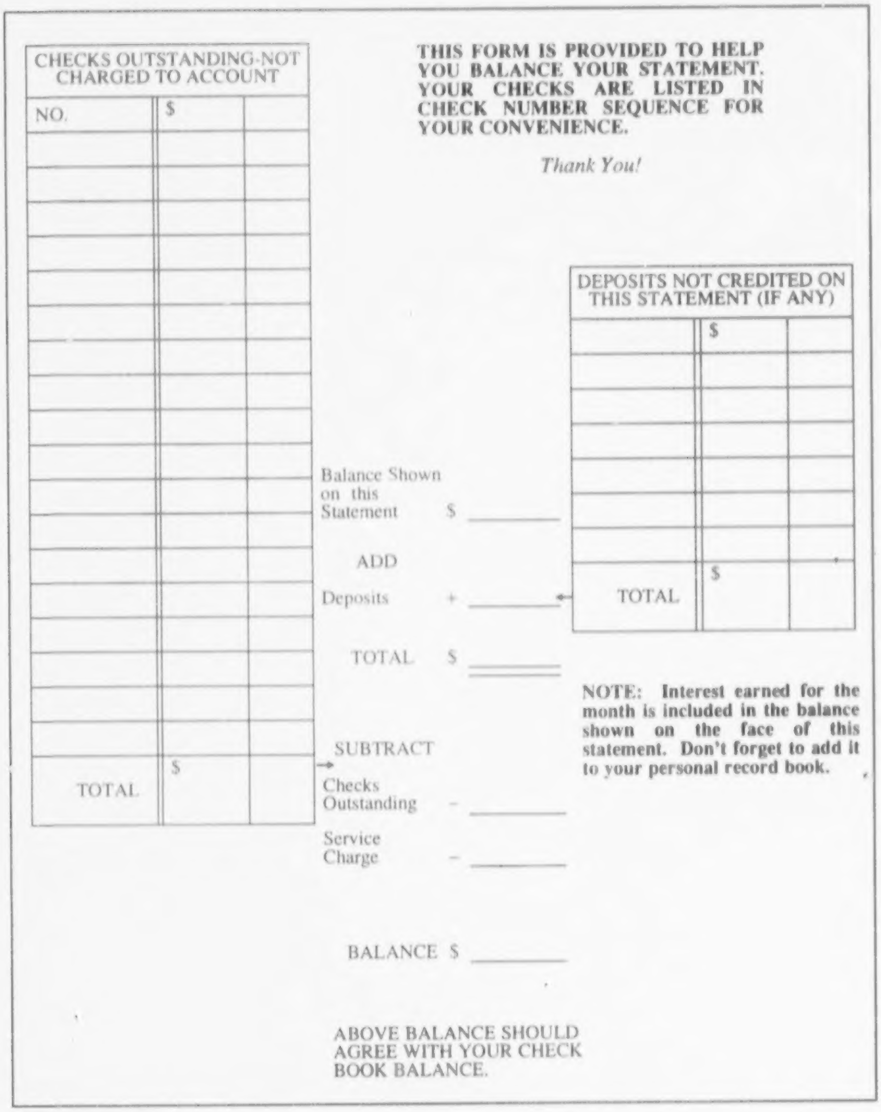
SC–SERVICE CHARGE	CC–CERTIFIED CHECK	OD–OVERDRAFT
EC– ERROR CORRECTED	DM–DEBIT MEMO	NC–NO COUNT
RT–RETURNED ITEM	CM–CREDIT MEMO	LS–TOTAL OF SEVERAL ITEMS

KINDLY NOTIFY THIS BANK IMMEDIATELY OF CHANGE OF ADDRESS

- Banks provide reconciliation forms on the back side of the monthly statements.
  - Use these forms to check the accuracy of the checking account balance.
- The steps to reconciling a bank statement are:
  1. Place the canceled checks in numerical order. Some banks list the canceled checks in numerical order on the monthly statement and do not return canceled checks.
  2. Compare the canceled checks to the checkbook register.
     - Examine the dollar amount in the checkbook register and make sure it matches the amount on the canceled check. This is a common place to make a mistake.
     - If the two figures agree, place a check mark beside the dollar amount in the check register and on the statement. This lets you know that the check was correct and has been canceled.
     - Correct any mistakes that might have been made when recording the amount of the check in the register.
  3. List on the reconciliation form the number and amount of all outstanding checks. Those are checks that have been written but do not appear on the bank statement.
  4. Total the outstanding checks and record the total on the correct line.
  5. Copy the statement balance onto the reconciliation form.
  6. Compare deposits shown on the bank statement to your check register. Place a check mark beside the amounts as they are compared.
     - Itemize outstanding deposits on the reconciliation form and then total the outstanding deposits.
     - Write the total amount of outstanding deposits on the correct line.
  7. Note any fees or service charges that appear on the bank statement. Record them in your check register and place a check mark after they have been entered. Record service charges on the reconciliation form.
  8. Add the deposits not credited to the balance shown on the statement. Record this amount next to "Total."

9. Subtract "Checks outstanding" and "Service charge" from "Total." This balance should agree with your checkbook.

10. If the adjusted bank balance and adjusted checkbook balance do not match, find the mistake and correct it. Calculate the addition and subtraction in the checkbook register again; this is usually where mistakes occur.



CHECKS OUTSTANDING-NOT CHARGED TO ACCOUNT		
NO.	$	
TOTAL	$	

THIS FORM IS PROVIDED TO HELP YOU BALANCE YOUR STATEMENT. YOUR CHECKS ARE LISTED IN CHECK NUMBER SEQUENCE FOR YOUR CONVENIENCE.

Thank You!

DEPOSITS NOT CREDITED ON THIS STATEMENT (IF ANY)		
	$	
TOTAL	$	

Balance Shown on this Statement $ ________

ADD

Deposits + ________

TOTAL $ ________

SUBTRACT

Checks Outstanding – ________

Service Charge – ________

BALANCE $ ________

NOTE: Interest earned for the month is included in the balance shown on the face of this statement. Don't forget to add it to your personal record book.

ABOVE BALANCE SHOULD AGREE WITH YOUR CHECK BOOK BALANCE.

ASSIGNMENT SHEET 1

PERFORMING GENERAL OFFICE WORK XII

NAME ______________________________ SCORE _______

OBJECTIVE 8 **Designate the correct filing order.**

INTRODUCTION Objective 1 discusses the rules for establishing an alphabetized filing system. Use the information in that objective to complete this assignment sheet.

DIRECTIONS List the following accounts in the correct alphabetical filing order.

_____ The Plant Patch
_____ Strawberry Hill
_____ AAA Greenhouse
_____ The Garden Gate
_____ A & M Plants
_____ Deer Park Plants
_____ Nowell's
_____ ABC Flowers

_____ Perfect Blooms
_____ Tiger Nursery
_____ Perry Produce
_____ Perkins Plant Farm
_____ Gibb's Garden Center
_____ Lane's Greenhouse
_____ Wilson's Farm Market
_____ Kelly's Flowers

ASSIGNMENT SHEET 2

PERFORMING GENERAL OFFICE WORK

XII

NAME ______________________________ SCORE ________

OBJECTIVE 9

Fill out a deposit slip.

INTRODUCTION

Objective 6 illustrates how to correctly fill out a deposit slip. Use the information in that objective to complete this assignment sheet.

DIRECTIONS

Use the information provided below to fill out the deposit slip for the days receipts.

Today's greenhouse receipts were:

2—50 dollar bills

31—20 dollar bills

42—10 dollar bills

84—5 dollar bills

134—1 dollar bills

$36.54—in coins

$27.42—check from Tom Smith

$98.10—check from Jane Evans

$ 6.45—check from Paul Stevens

$64.90—check from Kate Allen

$49.17—check from Kathryn Keys

CHECKING ACCCOUNT DEPOSIT TICKET

NAME ______________________________

____

____

DATE ____________________, 19____

____

Sign Here For Less Cash in Teller's Presence

HOMETOWN BANK

Yourtown, Oklahoma

ACCOUNT No. ______________________

CHECKS AND OTHER ITEMS ARE RECEIVED FOR DEPOSIT SUBJECT TO THE PROVISIONS OF THE UNIFORM COMMERCIAL CODE OR ANY APPLICABLE COLLECTION AGREEMENT

CASH	Currency		
	Coin		
List Checks Singly			
Total From Other Side			
TOTAL			
Less Cash Received			
NET DEPOSIT			

88-2398
1119

USE OTHER SIDE FOR ADDITIONAL LISTING

BE SURE EACH ITEM IS PROPERLY ENDORSED

PROPERLY ENDORSE ALL ITEMS

Checks List Singly	Dollars	Cents
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
TOTAL		
Enter Total On Front Of This Deposit Slip		
CASH COUNT		

	x 100		
	x 50		
	x 20		
	x 10		
	x 5		
	x 2		
	x 1		
TOTAL			

ASSIGNMENT SHEET 3

PERFORMING GENERAL OFFICE WORK

XII

NAME ______________________ SCORE ______

OBJECTIVE 10

Reconcile a bank statement.

INTRODUCTION

Objective 7 explains how to reconcile a bank statement, and why the reconciliation should be done quickly. The activity on this assignment sheet emphasizes this area.

DIRECTIONS

The Garden Gate received its December bank statement on December 24th. It stated that the checking account balance was $7413.92. A deposit was made on December 26th for $602.17 and another on December 30th for $164.50. The account was charged a $9.50 service charge for the month of December. There are four outstanding checks.

Check 906	$274.23
Check 909	$126.90
Check 911	$64.39
Check 915	$82.67

Garden Gate's checkbook register show a balance of $7622.90.

Use this information to fill out the reconciliation form and answer the following questions.

CHECKS OUTSTANDING-NOT CHARGED TO ACCOUNT		
NO.	$	
TOTAL	$	

THIS FORM IS PROVIDED TO HELP YOU BALANCE YOUR STATEMENT. YOUR CHECKS ARE LISTED IN CHECK NUMBER SEQUENCE FOR YOUR CONVENIENCE.

Thank You!

DEPOSITS NOT CREDITED ON THIS STATEMENT (IF ANY)		
	$	
TOTAL	$	

Balance Shown on this Statement $ ________

ADD

Deposits + ________

TOTAL $ ________

SUBTRACT

Checks Outstanding – ________

Service Charge – ________

BALANCE $ ________

ABOVE BALANCE SHOULD AGREE WITH YOUR CHECK BOOK BALANCE.

NOTE: Interest earned for the month is included in the balance shown on the face of this statement. Don't forget to add it to your personal record book.

1. What is the total of the outstanding checks? ______________
2. What is the amount of the adjusted bank balance? _________
3. Are there any mistakes in the checkbook register? _________

ASSIGNMENT ANSWERS

PERFORMING GENERAL OFFICE WORK

XII

ASSIGNMENT SHEET 1

Use the following criteria for evaluation.

AAA Greenhouse
ABC Flowers
A & M Plants
Deer Park Plants
Garden Gate, The
Gibb's Garden Center
Kelly's Flowers
Lane's Greenhouse
Nowell's
Perfect Blooms
Perkins Plant Farm
Perry Produce
Plant Patch, The
Strawberry Hill
Tiger Nursery
Wilson's Farm Market

ASSIGNMENT SHEET 2

See following page.

CHECKING ACCCOUNT DEPOSIT TICKET

NAME Frank's Greenhouse

DATE January 12, 19--

Sign Here For Less Cash in Teller's Presence

HOMETOWN BANK
Yourtown, Oklahoma

ACCOUNT NO. ⑆0000000001⑆⑈000000⑈

CASH	Currency	1694	–
	Coin	36	54
List Checks Singly			
Total From Other Side		246	04
TOTAL		1976	58
Less Cash Received			
NET DEPOSIT		1976	58

[redacted]

88-2398
1119

USE OTHER SIDE FOR ADDITIONAL LISTING

BE SURE EACH ITEM IS PROPERLY ENDORSED

CHECKS AND OTHER ITEMS ARE RECEIVED FOR DEPOSIT SUBJECT TO THE PROVISIONS OF THE UNIFORM COMMERCIAL CODE OR ANY APPLICABLE COLLECTION AGREEMENT

PROPERLY ENDORSE ALL ITEMS

Checks List Singly	Dollars	Cents
1. Smith	27	42
2. Evans	98	10
3. Stevens	6	45
4. Allen	64	90
5. Keys	49	17
6.		
7.		
8.		
9.		
10.		
TOTAL	246	04

Enter Total On Front Of This Deposit Slip

CASH COUNT

	x 100		
2	x 50	100	–
31	x 20	620	–
42	x 10	420	–
84	x 5	420	–
	x 2		
134	x 1	134	–
	TOTAL	1694	

ASSIGNMENT SHEET 3

1. $548.19
2. $7622.90
3. No

CHECKS OUTSTANDING-NOT CHARGED TO ACCOUNT		
NO.	$	
906	274	23
909	126	90
911	64	39
915	82	67
TOTAL	$ 548	19

THIS FORM IS PROVIDED TO HELP YOU BALANCE YOUR STATEMENT. YOUR CHECKS ARE LISTED IN CHECK NUMBER SEQUENCE FOR YOUR CONVENIENCE.

Thank You!

DEPOSITS NOT CREDITED ON THIS STATEMENT (IF ANY)		
12/26	$ 602	17
12/30	164	50
TOTAL	$ 766	67

Balance Shown on this Statement $ 7413.92

ADD

Deposits + 766.67

TOTAL $ 8180.59

SUBTRACT

Checks Outstanding – 548.19

Service Charge – 9.50

BALANCE $ 7622.90

ABOVE BALANCE SHOULD AGREE WITH YOUR CHECK BOOK BALANCE.

NOTE: Interest earned for the month is included in the balance shown on the face of this statement. Don't forget to add it to your personal record book.

PERFORMING GENERAL OFFICE WORK

NAME ______________________ SCORE ______

OBJECTIVE 1

Select from a list true statements about arranging a filing system. Write an "X" in the blank before each true statement.

____ 1. Filing is most commonly done using a numerical system for customer addresses.

____ 2. Cardboard boxes are a good choice for holding files because they are cheap and easy to move.

____ 3. Manila folders with index tabs should be used to hold records in each file.

____ 4. Colored folders can be used to distinguish between different kinds of files.

____ 5. Alphabetical files are placed in a drawer with the A's in the back of the drawer and the Z's in the front.

____ 6. AAA greenhouse would be filed before Anderson greenhouse.

____ 7. If two files have the same last name, the customer who has bought from your greenhouse the longest is filed first.

____ 8. Any invoice, receipt or correspondence from a customer should be placed in the customer's file.

____ 9. Current invoices or records should be placed on top of the information already in a file.

____ 10. Filing should be done once a month.

OBJECTIVE 2

Select from a list true statements about office supplies and equipment. Write an "X" in the blank before each true statement.

____ 1. After making a list of needed items place the order immediately.

____ 2. An extra box/package of each supply should be held in storage.

____ 3. Employees who use the last of an item should write it on the request sheet.

____ 4. Office supply companies usually charge to deliver items to the greenhouse.

____ 5. Office personnel don't have to worry about monitoring office equipment since service repair personnel will take care of that responsibility.

____ 6. Quick inventories of supplies done at the end of every month will help eliminate running out of supplies.

____ 7. Office equipment should be insured.

OBJECTIVE 3

Discuss the proper procedures for handling telephone calls.

1. Write two opening phone statements for the Flower Basket greenhouse.

____

____

____

2. Why should greenhouse employees put a "smile" in their voice when talking on the telephone?

____

____

____

3. What should be the last statement made to a person who calls the greenhouse?

____

____

____

4. List the important facts that must be included in a telephone message.

OBJECTIVE 4

Discuss mail handling procedures.

1. Why should the mail be handled every day?

2. How should employees handle checks which arrive in the mail?

OBJECTIVE 5

Complete statements about maintaining a mailing list. Write the missing words in the blanks.

1. New information should be added to the existing mailing list once a ____________________ .
2. Any ____________________ in names or addresses should be included in the update.
3. ____________________ names should be added and inactive names removed.
4. Designate a file or box to hold all new data for the mailing list. ____________________ all changes once a week.
5. One specific ____________________ should be set aside for updating the mailing list.

OBJECTIVE 6

Select from a list true statements about preparing a bank deposit. Write an "X" in the blank before each true statement.

____ 1. All checks to be deposited must be endorsed by hand.

____ 2. Checks and cash received at the greenhouse should be deposited in the bank at the end of each business day.

____ 3. As a safety measure, checks should be endorsed as soon as they are received.

____ 4. Only checks must be totaled on the deposit slip, the bank teller will count the cash.

____ 5. Checks must be listed singly on the deposit slip.

____ 6. Do not use the bottom half of the back of the deposit slip for a business deposit.

____ 7. The depositor must always sign the front of the deposit slip.

____ 8. Always fill in the date on the deposit slip.

OBJECTIVE 7

Arrange in order the steps in reconciling a bank statement. Place a "1" in the blank before the first step, a "2" in the blank before the second step, and so on.

_____ Total the outstanding checks and record the total on the correct line.

_____ Compare the canceled checks to the checkbook register.

_____ Copy the statement balance onto the reconciliation form.

_____ Place the canceled checks in numerical order.

_____ List on the reconciliation form the number and amount of all outstanding checks.

_____ Compare deposits shown on the bank statement to your check register. Place a check mark beside the amounts as they are compared.

_____ Add the deposits not credited to the balance shown on the statement. Record this amount next to "Total."

_____ Note any fees or service charges that appear on the bank statement. Record them in your check register and place a check mark after they have been entered.

_____ Subtract "Checks Outstanding" and "Service Charge" from "Total." This balance should agree with your checkbook.

______ If the adjusted bank balance and adjusted checkbook balance do not match, find the mistake and correct it.

NOTICE The following assignment sheets are not part of the written test. If these activities have not been completed, check with your instructor.

OBJECTIVE 8 **Designate the correct filing order.** SCORE ________

OBJECTIVE 9 **Fill out a deposit slip.** SCORE ________

OBJECTIVE 10 **Reconcile a bank statement.** SCORE ________

WRITTEN TEST ANSWERS

PERFORMING GENERAL OFFICE WORK

XII

OBJECTIVE 1

3, 4, 6, 8, 9

OBJECTIVE 2

2, 3, 6, 7

OBJECTIVE 3

1. Answers will vary but should include the name of the greenhouse and the employee who is speaking.
2. A caller gets an image of the business by how the employees voice and manner sounds over the telephone.
3. Thank them for calling and offer help or service in the future.
4. Answer should include:
    - Name of person to receive the message
    - Date and time of call
    - Caller's company name
    - Caller's telephone number
    - Response requested

OBJECTIVE 4

1. To keep up with bills to be paid and checks which arrive.
2. Answer should include:
    - Stamped for deposit
    - Recorded as received
    - Placed in the cash register
    - Deposited at the end of the day

OBJECTIVE 5	1. Week 2. Changes 3. New 4. Enter 5. Day
OBJECTIVE 6	2, 3, 5, 8
OBJECTIVE 7	4, 2, 5, 1, 3, 6, 8, 7, 9, 10
OBJECTIVE 8	Refer to answers to Assignment Sheet 1.
OBJECTIVE 9	Refer to answers to Assignment Sheet 2.
OBJECTIVE 10	Refer to answers to Assignment Sheet 3.

OBJECTIVE SHEET

MAINTAINING GREENHOUSES

XIII

INTRODUCTION

Greenhouses are like any other structure or machine, they eventually break down and must be repaired. The constant exposure to warm, humid conditions and bright sunlight causes rapid deterioration of a greenhouse and its contents. However, routine maintenance and upkeep greatly reduce the destruction process.

UNIT OBJECTIVE

After completing this unit, the student should be able to prevent the onset of major greenhouse deterioration and repair day to day problems. The student will demonstrate these competencies by completing an assignment sheet and written test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Recommend maintenance and repair procedures for greenhouse interiors.
2. Select from a list true statements about maintenance and repair procedures for exterior greenhouse surfaces.
3. Discuss factors related to replacing the plastic cover on a greenhouse.
4. Select from a list true statements concerning servicing of electrical systems.
5. Discuss procedures for maintaining a greenhouse structure during severe weather conditions.
6. Compile a list of needed maintenance and repair procedures for your school's greenhouse. (Assignment Sheet 1)

SUGGESTED ACTIVITIES

MAINTAINING GREENHOUSES

XIII

PREPARATION

- Obtain materials to supplement unit.

  NOTE: See Suggested Resources.

- Review instructional outline for this unit. Modify time frames to suit class needs and plan activities for each class period.

- Study the specific objectives to determine those you will cover in your presentation. Decide also which objectives should be taught to which students.

- Determine scope and sequence of objectives that you add. Design and develop support materials, including evaluation techniques, for additional objectives.

- Determine how you will schedule time for students to demonstrate competence in the required procedures.

- Make arrangements for guest speakers. Supply speakers with specific objectives and other appropriate sections of the unit.

- Develop a slide set or picture file of greenhouses damaged by severe weather conditions.

DELIVERY

Objectives 1 and 2

- Introduce the topic of maintaining greenhouses. Stress the importance of properly maintaining and repairing greenhouses.

- Discuss maintenance and repair procedures for greenhouse interiors.

- Discuss maintenance and repair procedures for exterior greenhouse surfaces.

- Discuss with students the normal deterioration of greenhouse structures. Show slides that illustrate deterioration of greenhouses.

602

Objective 3

- Discuss the procedures for replacing the plastic cover on a greenhouse.

Objective 4

- Discuss servicing of electrical systems.

Objective 5

- Discuss procedures for maintaining a greenhouse structure during severe weather conditions. Ask students what types of severe weather conditions are most likely to occur in your area.
- Show slides of greenhouses damaged by severe weather conditions.

APPLICATION

Objective 6

- Use Assignment Sheet 1 to teach students how to spot repair and maintenance needs.

EVALUATION

Written Test

- Explain to students that they will be asked to demonstrate on the written test actions listed in the specific objectives.
- Give written test.

  NOTE: Written test may be given in sections if desired.

- Evaluate students on assignment sheet activity if not previously done.
- Reteach and retest if necessary.
- Complete appropriate section of competency profiles.
- Review individual and group performance in order to evaluate teaching methods. Adjust scope, sequence, or instructional approaches for additional lessons as required.

SUGGESTED RESOURCES

Audiovisual Materials

- *Electrical Wiring*. 1/2" VHS, color, 41 min., 1987, Leichtung Workshops. Available from Leihtung Workshops, 4944 Commerce Parkway, Cleveland, OH 44128, phone 800-321-6840. Learn the basic wiring terms and techniques, how to install light fixtures and switches (including a 3-way switch, switched receptacle, and ground-fault interrupter receptacle). Learn how to plan and rough in wiring for new construction.

  NOTE: This video is available to Oklahoma teachers on a free-loan basis. Oklahoma teachers may order this video from the Oklahoma Department of Vocational and Technical Education, Resource Center, ATTN: Instructional Media Specialist, 1500 W. Seventh Avenue, Stillwater, OK 74074, 1-800-522-5810.

UNIT REFERENCES

- Laurie, Alex et al., *Commercial Flower Forcing*, 8th ed., McGraw-Hill Book Co., New York, New York, 1979.
- Nelson, Kennard S., *The Greenhouse Grower, a Career in Floriculture*, The Interstate Printers and Publishers, Inc., Danville, Illinois, 1977.
- Nelson, Paul V., *Greenhouse Operation and Management*, 3rd ed., Reston Publishing Co., Reston, Virginia, 1985.

BASIC ACADEMIC SKILLS

The following table identifies the basic academic skills that are reinforced in this unit of instruction. These basic academic skills were identified using *The Basic/Essential Skills Taxonomy*, 2nd edition, and verified during the validation process.

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 1	Language Arts 098	Composes/ Edits	Reports/ essays	Summaries
	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
OBJECTIVE 2	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity
	Language Arts 013	Applies/Uses	Definitions	
OBJECTIVE 3	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
	Science 342	Describes/ Explains	Matter	Properties
	Science 343	Describes/ Explains	Matter	Structure
OBJECTIVE 4	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 5	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
	Science 342	Describes/ Explains	Matter	Properties
	Science 343	Describes/ Explains	Matter	Structure
OBJECTIVE 6	Language Arts 035	Attends	Directions/ task	

OBJECTIVE 1

Recommend maintenance and repair procedures for greenhouse interiors.

Surfaces inside a greenhouse quickly begin deteriorating due to high humidity, warm temperatures, and the chemicals used during plant production. This process can be reduced through the use of preventive maintenance and timely repairs.

- **Greenhouse frames**—The type of material the greenhouse frame is made of will determine how much maintenance will be required.
  - Galvanized metal is relatively maintenance free. This type of structural material is strong and long lasting.
  - Nongalvanized steel frames rust and corrode over time. To prevent the rusting process, paint the metal so it is protected from moisture.

    The frame will eventually need to be painted. Make sure the metal is cleaned with a wire brush to remove loose paint and rust, rust neutralized, and then painted.

    Use white paint; it reflects the most light. The paint should be an outdoor type enamel because it withstands moisture better.
  - Wood requires the most maintenance. It must be cleaned and painted every 2-3 years to prevent the wood from rotting.

    Chromated Copper Arsonate pressure treated lumber is waterproof and will last longer than nontreated wood. It may be desirable to paint it white to reflect light.

    Rotted wood must be replaced. Be sure to use redwood or CCA pressure treated lumber when replacing rotted parts of the frame.

- **Structural coverings**—Require routine maintenance and repairs.
  - Rigid coverings attract dirt and dust due to static electricity. The dirt that coats the covering reduces the light intensity inside the greenhouse.

    Wash the covering every two years. Use a mild household detergent and a soft brush. Thoroughly rinse the covering with a pressurized water spray.

    Seal any cracks or crevices that may develop between the covering and frame with polyurethane squirt foam.
  - Polyethylene coverings also attract dirt and dust. They can be washed but care must be used so the film is not torn.

    Usually these coverings are just hosed off with water to rinse the dirt away.

    If the interior layer of poly becomes torn or punctured, immediately cover the hole with polyethylene tape. Large tears or holes may have to be patched.

    By quickly repairing small damaged areas on a poly covering you prevent the hole or tear from becoming large and non-repairable.
- **Benches**—The construction will determine how much maintenance and how repairs will be needed.
  - Galvanized metal benches require very little maintenance. They should be washed and sterilized several times a year for disease control.
  - Wooden frame benches will require cleaning and painting every 2-3 years to protect the wood from rot.

    Use CCA pressure treated wood and white exterior paint for maximum waterproofing and light reflection.

    Chipped and peeling paint must be completely removed before new paint is applied.

    Any rotted boards in the bench frame should be replaced with new ones as soon as detected.

Recover bench tops with new wire when the old wire becomes brittle and breaks. Vinyl coated wire is now available for greenhouse bench use. This coating protects the wire from chemicals and fertilizers that cause the wire to become brittle and break.

- **Walkways and floors**—These must be examined for damage and hazardous conditions.
  - Gravel has a tendency to get mashed into the soil when walked on. New gravel must be brought in and spread on the floor as the old disappears.

    Do not allow the greenhouse floor to become a mud slick. If customers or employees slip and fall, the greenhouse could be sued for negligence.
  - Concrete floors and walks will settle and crack over time. Severe cracks should be patched to prevent injury.

    If settling disturbs the drainage pattern, areas of the floor or walk will have standing water. Algae and moss will grow in these puddles and create slippery spots.

    Treat slick spots with chemicals to kill the algae and prevent slippery spots. You may have to correct the drainage pattern if the problem is severe.
- **Drains**—The drains in the greenhouse will periodically become clogged.
  - To reduce the problem make sure all drains are covered with a lid that prevents large particles from entering the drainage system. The lid will also keep people from tripping or falling due to an open drain.
  - Whenever a drain seems to be running slowly try to clean it out. Rubber bulbs that use water to create pressure in the drain can be purchased at a hardware store. These bulbs will open slow running drains.
  - Severely clogged or stopped up drains will require a professional plumber.
- **Jet tubes**—These are usually replaced on a yearly basis.
  - Sunlight degrades jet tube plastic making it brittle and causing it to crack or tear.

- Fall is the normal time to install jet tubes. They are not needed in the summer and sunlight will only start degrading the plastic.
- Install a jet tube so the air is directed downward toward the benches and not up at the roof. Ultra-violet resistant jet tubes are available; they last longer than regular tubes but cost more.

OBJECTIVE 2 **Select from a list true statements about maintenance and repair procedures for exterior greenhouse surfaces.**

- Exposure to the elements is harmful to the greenhouse structure. Maintenance and repair procedures help extend the life of exposed surfaces.
- The greenhouse covering receives the harshest treatment from the outdoor conditions. The sun deteriorates and weakens the cover, the wind exerts pressure and pulls at the cover, and rain, snow and ice add additional weight the cover must support.
- Rigid covers need to be periodically washed to remove dirt, shade compounds and degraded layers of the covering. Washing should be done every 2-3 years.
    - A household detergent and a medium stiff brush should be used to scrub off the debris. Rinse off the soap solution with plain water.
    - Ultra-violet light destroys the protective coating on fiberglass and the covering begins to degrade. Fibers are exposed to outdoor conditions and collect dirt. Washing removes the dirt and the exposed fibers and allows more light to enter the greenhouse.
    - As soon as old fiberglass is washed, it should be coated with a new layer of UV protector. This material is painted on and can be purchased from a horticultural supply company. Other types of rigid coverings do not need this protective coating.
    - Repair any holes or cracks in the cover. Cracks and small holes can be filled with silicone and smoothed over. Larger holes may have to be patched; cut a piece of spare covering slightly larger than the damaged area and glue it to the outside of the covering using silicone. When the silicone has cured the patch will permanently cover the hole and light will still enter.

  - Areas that are severely damaged may need a new sheet of covering installed.

  - Some pieces of roof covering may come loose and need to be retightened. If the covering can be heard vibrating or shaking in the wind it needs to be repaired. Retighten the fasteners that hold the sheet in place and put in additional ones if necessary. A loose covering could be ripped from the greenhouse in a strong wind storm.

- Polyethylene coverings do not stay on a greenhouse long enough to be washed. They can be hosed off with water in the early spring to remove the dust and dirt.

  - These covers are very susceptible to damage and must be repaired quickly to prevent further damage.

  - Small rips and holes can be taped with special polyethylene tape available from horticultural suppliers.

  - Moderate holes or tears can be patched by taping a piece of extra poly over the damaged area.

  - Severely damaged polyethylene may have to be completely replaced. Recovering a greenhouse with poly is expensive and can only be done during certain times of the year. Try any type of repair technique before recovering a greenhouse!

- The exhaust stacks must be checked to make sure they are removing all the fumes from the heater.

  - Make sure the stacks are designed so birds cannot enter. A wire covering may need to be installed to keep the birds out.

  - Check the stacks for nests. A nest could start a fire or prevent the fumes from being drawn from the greenhouse.

  - See that the stacks are securely fastened together and that they are attached properly to the greenhouse.

- Doors to the greenhouse should close properly to conserve energy.
    - Periodically adjust them so they shut tightly and at a normal speed. A door that closes too fast may injure someone and a door that closes very slowly can be caught by the wind and pulled open.
    - Use any insulation devices that will make the doors more energy efficient. During the winter months, seal off any doors that are not necessary.
- Gutters and downspouts should be inspected for leaks or damage.
    - Remove leaves and any other trash that may have collected.
    - Check for loose or improperly attached gutters.
    - Make sure the downspouts direct water away from the stem wall.
- Miscellaneous maintenance tasks include mowing the grass near the greenhouse. Tall grass and weeds are unattractive and they attract insects and rodents.
    - Observe drainage near the greenhouse during the rainy season and make sure water runs away from the greenhouse. Regrade the slope if necessary.

OBJECTIVE 3 **Discuss factors related to replacing the plastic cover on a greenhouse.**

Polyethylene is not a permanent greenhouse covering and must be installed every 2-4 years. The plastic has to be cut to fit each greenhouse and installers must know how to properly put the plastic on so it will not be wasted or ruined.

1. Remove the old plastic and dispose of properly . Many landfills will not accept plastic so you will have to decide how to dispose of the plastic before it is removed.
    - Some companies now give greenhouse operators credit for the old plastic when they buy new material. The greenhouse must ship the old plastic to a processing plant before credit will be given.

2. Inspect the greenhouse frame for any damage or rough spots while the cover is off. Now is the time to make any repairs or alterations. Also inspect the method of attaching the plastic; is the poly lock in good shape? Have all the staples and nails been removed from last year's attachment?

3. Weather conditions must be proper for installing polyethylene. There should be very little or no wind. Strong wind makes it difficult to handle the plastic. If it is breezy, the exhaust fans can be turned on to help hold the plastic in place on the greenhouse frame.

   - The temperature should be above 45° F and below 70° F.

   - When the temperature is too low the plastic is stiff and the installers will not be able to stretch it tight over the greenhouse. Plastic that is applied during cold weather looks good and fits tight until the temperature warms up. As the temperature increases the plastic expands, loosens and moves around on the frame. Moving plastic deteriorates faster due to abrasion on the frame.

4. Lay the plastic out but do not unfold it.

   - The plastic should be at least 2 feet wider than needed; this extra width gives the installers a place to hold while they stretch the plastic. The length of the plastic should be at least 2 feet longer than the greenhouse length.

   - If double layer plastic is going to be installed cut both pieces.

5. Attach the plastic to one entire side of the greenhouse while it is still folded. There should be 8-10 inches of plastic below the attachment point; try to get it as straight as possible when attaching it.

6. Place a ball about 12 inches from the corner on the remaining edge and tie it in place with a rope. The rope will be tossed over the greenhouse and then reeled in to pull the plastic across the greenhouse top.

   - One person will have to remain on the side where the plastic is attached to unfold it as it is pulled across the greenhouse.

7. Stretch the plastic tight and lock it in place. Roll a wooden lath into the edge of the plastic to use as a handle to pull the plastic; this prevents finger holes from being torn in the plastic.

   - Do not apply plastic if it is misting or raining. Wet plastic is very difficult to apply.

8. Cover the ends of the greenhouse with plastic just like it was applied on the greenhouse.

9. Attach a squirrel cage fan inside the greenhouse to inflate the area between the two layers of plastic.

   - A plus mark shaped cut is made in the interior layer of the plastic. Insert a piece of 4 inch flexible dryer hose into the hole. Pull the four flaps from the cut inside the greenhouse and tape them to the hose using polyethylene tape. This will seal the hole and make it airtight. Connect the hose to the squirrel cage fan and inflate the plastic.

   - The air space between the layers of plastic should be between one-half and four inches. More or less space does not provide proper insulation.

   - The squirrel cage fans should have an adjustment valve on the side that can be used to regulate the pressure between the layers. Adjust the fan so the proper amount of air is supplied under various weather conditions.

10. Trim the excess plastic from the attachment area. Leave a 2-3 inch flap of plastic; this prevents the plastic from being pulled out from under the attachment device.

OBJECTIVE 4

Select from a list true statements concerning servicing of electrical systems.

- Electricity is vital to the operation of a greenhouse. It is used to heat and cool the house, to power the mist system and to supply supplemental lighting.

- A basic understanding of electricity is needed by greenhouse employees. They must also be aware of the dangers associated with electricity and that it can be fatal if misused.

- **Never** attempt to repair or install 240 volt power. Hire a professional electrician.

- Most electrical wiring is required by law to be installed by a professional electrician. Check your local ordinances for laws affecting the greenhouse.
- Simple repairs like replacing electrical cords, switches, relays or fuses can be done by greenhouse personnel. Always disconnect the main power supply to the item being repaired before beginning work.
- Label all breakers and fuses so employees know what equipment is controlled by each fuse or breaker.
- Check all breakers and fuses when an electrical item is not working. No electricity can reach an electrical device if the breaker is tripped or a fuse is blown.
- Repeated breaker tripping or fuse blowing tells you there is a short in the circuit somewhere or a motor is pulling too much current.
- Protect electrical outlets from moisture. Ground fault outlets are designed to keep moisture out; they are available from any electrical supply company and should always be used in a greenhouse.
- Annually inspect all electrical equipment for defective cords or wiring, corrosion or signs of improper use.
- Lubricate motors and bearings as suggested by the manufacturer.

OBJECTIVE 5

Discuss procedures for maintaining a greenhouse structure during severe weather conditions.

Most greenhouses are not designed to withstand severe weather conditions. However, there are management practices a greenhouse grower can perform to help the structure survive severe weather.

- **Extremely cold weather** makes it difficult to keep a greenhouse warm. Turn the thermostat up a few degrees in the evening to supply additional heat overnight. Check the high-low thermometer in the morning and use the reading on the thermometer to estimate how much the thermostat should be increased.
  - During extended periods of cold weather, check the greenhouse for air leaks and seal them.

- **Snow** puts a lot of extra weight on the greenhouse cover and frame. A polyethylene cover could tear due to the weight of the snow; greenhouse frames also collapse because of this extra weight.
  - When snow begins to accumulate on a greenhouse roof raise the temperature a few degrees to speed up the melting process.
  - The squirrel cage fan that inflates a poly greenhouse should be turned off when snow starts to accumulate on the greenhouse. When the insulating air layer is removed, heat will escape from the greenhouse through the plastic and melt the snow. If the air layer remains inflated very little heat will be lost through the plastic and the snow will pile up.
  - When snow is rapidly falling it cannot melt fast enough to run off the house and must be manually removed. The gutters of gutter connected greenhouses must be swept out to remove the snow load.
  - Quonset houses that do not have a steep slope must be swept off. Use a floor broom and carefully pull the accumulating snow off of the greenhouse.
- **Ice storms** present a difficult problem for the greenhouse grower. These storms often come on with little warning and no time to prepare. Ice storms add much weight to the greenhouse roof and often cause the structure to collapse. Also, the ice sticks to the house and cannot be swept off.
  - Remove hanging baskets in an even manner from the greenhouse frame.
  - Deflate poly greenhouses to try and melt the ice off.
  - Increase the temperature in the greenhouse to help melt the ice faster.
  - Place braces inside the greenhouse to give the roof extra support if possible.
  - Remove valuable crops from poorly constructed greenhouses and put them in a stronger greenhouse.

  - Try breaking the ice into small sections when it is a *very thin layer*. Gently push outward on the roof covering from the inside trying to break the sheet of ice into smaller pieces that will slide off the greenhouse. Be very careful because the greenhouse covering will be brittle and could easily tear or crack.

- **Wind storms** commonly rip the cover off a greenhouse.

  - Make sure the greenhouse cover is applied as tightly, and securely as possible. One loose spot can get caught in the wind and tear the entire cover off the greenhouse.

  - If a loose spot develops quickly attach the area back to the greenhouse.

  - Do not remain in a greenhouse during severe wind storms or tornadoes. These structures are not capable of protecting employees or customers during this type of storm.

- **Heavy rains** can be a problem on a greenhouse that does not have enough slope on the roof. A pitched roof will channel the water to the gutter and drain it off the greenhouse.

  - Flat roofs or low profile quonset greenhouses often collect water in low spots. The extra weight of this water pocket causes the cover to sag toward the greenhouse interior and could possibly tear the cover or collapse the structure.

  - Use a T-shaped PVC plunger to push up on the water pocket and force the water to drain off the roof. Keep an eye on this interior bulge and drain it as often as needed.

  - Employees should not stay in a greenhouse during a severe electrical storm. The metal in the greenhouse frame could draw a lightning strike and cause personal injury.

ASSIGNMENT SHEET 1

MAINTAINING GREENHOUSES

XIII

NAME ______________________________ SCORE _______

OBJECTIVE 6 **Compile a list of needed maintenance and repair procedures for your school's greenhouse.**

INTRODUCTION Objectives 1 and 2 stressed the importance of preventive maintenance and quick repairs to keep a greenhouse operating smoothly. Use the information in those objectives to complete this assignment sheet.

DIRECTIONS Observe the interior and exterior of your school's greenhouse and make a list of preventive maintenance procedures that should be done. In a separate list write down any repairs that need to be made.

Preventive Maintenance	Repairs
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________

ASSIGNMENT ANSWERS

MAINTAINING GREENHOUSES XIII

ASSIGNMENT SHEET 1

Use the following criteria for evaluation:

- The student should observe the following and make recommendations.
  - greenhouse frame
  - covering
  - floors
  - drains
  - gutters and downspouts
  - doors
  - benches
  - exhaust vents
  - electrical items
  - jet tubes
- Notes should be made about the immediate repairs and preventive treatments that should occur during the year.

WRITTEN TEST

MAINTAINING GREENHOUSES

XIII

NAME ______________________ SCORE ______

OBJECTIVE 1

Recommend maintenance and repair procedures for greenhouse interiors.

1. How often should a wooden greenhouse frame be painted and what type of paint should be used?

2. What kind of wood is the most durable in greenhouses?

3. Why should the interior surfaces of greenhouse coverings be periodically washed?

4. What type of maintenance and repairs are necessary when a greenhouse has a gravel floor?

5. When are jet tubes normally installed, and why?

____

____

____

____

OBJECTIVE 2

Select from a list true statements about maintenance and repair procedures for exterior greenhouse surfaces. Write an "X" in the blank before each true statement.

____ 1. Exposure to the elements is harmful to greenhouse covers.

____ 2. The exterior surface of a poly greenhouse cover is washed once a year to remove dirt and degraded layers of the covering.

____ 3. A detergent solution and a medium stiff brush should be used to scrub a rigid greenhouse cover.

____ 4. As soon as an old fiberglass covering is washed it should be coated with a new layer of ultra-violet protector.

____ 5. Ultra-violet light degrades fiberglass by causing the fibers to sink deeper into the sheet.

____ 6. Small holes in rigid coverings can be filled with silicone.

____ 7. A large hole in a fiberglass covering is repaired by gluing a piece of fiberglass slightly larger than the hole on the inside of the greenhouse using silicone.

____ 8. Special polyethylene tape is available to repair small rips and tears in polyethylene coverings.

____ 9. Moderate sized rips or tears in poly covering can be patched using an extra piece of poly and polyethylene tape.

____ 10. Nests in an exhaust stack could cause a fire.

____ 11. Downspouts should carry water off the greenhouse roof and pour it near the greenhouse foundation.

____ 12. Greenhouse doors should be adjusted to close very slowly so customers have time to enter without being hit by the door.

OBJECTIVE 3 **Discuss factors related to replacing the plastic cover on a greenhouse.**

1. List the ideal weather conditions for covering a greenhouse with plastic.

2. What happens to a plastic greenhouse cover that was applied on a cold day when the weather becomes warm?

3. How should a piece of plastic be cut when covering a greenhouse?

4. Describe how to attach a squirrel cage fan to the poly covering for air inflation.

5. What is the ideal air space between layers on an air inflated poly greenhouse?

____

____

____

OBJECTIVE 4

Select from a list true statements concerning servicing of electrical systems. Write an "X" in the blank before each true statement.

____ 1. Electricity is dangerous and can be fatal if misused.

____ 2. Electricity is needed to heat and cool the greenhouse and to operate the mist system.

____ 3. Most wiring, including the installation of 240 volt lines can be done by greenhouse employees.

____ 4. Replacing damaged electrical cords is a job greenhouse employees can easily do.

____ 5. Always disconnect the main power supply before repairing any electrical item.

____ 6. If an electrical item is not working first check and see if the breaker is tripped or if a fuse has been blown.

____ 7. Moisture in a greenhouse does not harm electrical outlets.

____ 8. Inspect all electrical items once every two years for defective cords or wiring, corrosion or signs of improper use.

____ 9. Breakers and fuses should be labeled so employees know what each breaker or fuse controls.

___ 10. Lubricate motors and bearings once a year.

OBJECTIVE 5

Discuss procedures for maintaining a greenhouse structure during severe weather conditions.

1. What should a grower do during extremely cold weather to keep the desired temperature in the greenhouse?

____

____

____

____

2. What should a grower do when snow is rapidly accumulating on an air inflated poly greenhouse?

____

____

____

____

3. Why are ice storms so difficult for a greenhouse grower to deal with?

____

____

____

____

4. Wind storms generally do what type of damage to a greenhouse?

____

____

____

____

5. How can a grower get rid of a pocket of water that has collected on a poly covered greenhouse?

____

____

____

____

NOTICE The following assignment sheet is not part of the written test. If this activity has not been completed, check with your instructor.

OBJECTIVE 6 **Compile a list of needed maintenance and repair procedures for your school's greenhouse.** SCORE ________

WRITTEN TEST ANSWERS

MAINTAINING GREENHOUSES

XIII

OBJECTIVE 1

1. Every 2-3 years

   White exterior enamel paint

2. Redwood or CCA pressure treated lumber
3. To remove dust and dirt so more light enters the greenhouse.
4. Add new gravel as the old is mashed into the soil.
5. New jet tubes are put up in the fall. They are not needed until the fall and if they are installed in the summer the sunlight begins degrading the plastic.

OBJECTIVE 2

1, 3, 4, 6, 8, 9, 10

OBJECTIVE 3

1. Little or no breeze

   Temperature between 45° F and 70° F

2. The plastic will expand and be too loose.
3. At least 2 feet wider than what is needed to cover the house and 2 feet longer than the length of the house.
4. Make a plus shaped cut in the interior layer of plastic.

   Insert a 4 inch flexible dryer hose into the hole.

   Pull the four plastic flaps inside the greenhouse and tape them to the dryer hose. This will seal the cuts and make it air tight.

   Attach the hose to the squirrel cage fan.

5. One-half to four inch air space between the layers.

OBJECTIVE 4

1, 2, 4, 5, 6, 9

OBJECTIVE 5

1. Increase the thermostat setting to compensate for the heat loss due to very cold weather.

   Seal any air leaks.

2. Increase the temperature of the house.

   Deflate poly.

   Sweep gutters.

   Sweep snow off the roof.

3. Little warning with no time to prepare.

   Lots of weight.

   Ice sticks to the greenhouse and cannot be swept off.

4. Rip the cover off.

5. Use a T-shaped PVC plunger to push the water pocket up and allow the water to run off.

OBJECTIVE 6

Refer to answers to Assignment Sheet 1.

OBJECTIVE SHEET

SERVICING AND MAINTAINING EQUIPMENT

XIV

INTRODUCTION

The successful operation of any greenhouse depends on smooth and trouble free performance of all equipment. A greenhouse relies on fans to cool the house, a pump to supply water to the cooling pads, and delivery trucks to ship greenhouse products. Keeping machinery in top operating condition requires that routine maintenance and service procedures be done on all equipment.

UNIT OBJECTIVE

After completing this unit, the student should be able to set up maintenance and service procedures for all equipment used at a greenhouse. The student will demonstrate these competencies by completing the assignment sheets, job sheets and written test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. List the major maintenance points for greenhouse fans.
2. State required maintenance procedures for a greenhouse cooling system.
3. Select from a list true statements concerning maintenance of automatic watering systems.
4. Distinguish between service and maintenance of sprayers.
5. Complete statements about the maintenance of hand tools.
6. Describe service procedures for business vehicles.
7. Select from a list true statements about servicing tractors, trailers and other machinery.
8. List the major service procedures for small 2-cycle and 4-cycle engines.
9. List important information that should be recorded on service reports.
10. Complete statements about cleaning the work and delivery areas.
11. Design a service record form. (Assignment Sheet 1)
12. Create a schedule for cleaning the greenhouse and work area. (Assignment Sheet 2)
13. Demonstrate the ability to change a fan belt. (Job Sheet 1)

SUGGESTED ACTIVITIES

SERVICING AND MAINTAINING EQUIPMENT

XIV

PREPARATION

- Obtain materials to supplement unit.

  NOTE: See Suggested Resources.

- Review instructional outline for this unit. Modify time frames to suit class needs and plan activities for each class period.

- Study the specific objectives to determine those you will cover in your presentation. Decide also which objectives should be taught to which students.

- Determine scope and sequence of objectives that you add. Design and develop support materials, including evaluation techniques, for additional objectives.

- Determine how you will schedule time for students to demonstrate competence in the required procedures.

- Make arrangements for guest speakers. Supply speakers with specific objectives and other appropriate sections of the unit.

DELIVERY

Objective 1

- Introduce the topic of servicing and maintaining equipment. Stress the importance of properly maintained equipment.

- Discuss the major maintenance points for greenhouse fans.

Objectives 2 through 5

- Discuss maintenance procedures for a greenhouse cooling system.

- Discuss maintenance of automatic watering systems.

- Discuss service and maintenance of sprayers.

- Discuss maintenance of hand tools.

- Remind students that safety procedures should always be followed when servicing equipment.

- Invite a maintenance person from a large nursery or greenhouse to discuss servicing greenhouse equipment. If possible, have the speaker walk through the greenhouse and show students how to service the equipment.

Objectives 6 through 8

- Discuss service procedures for business vehicles.
- Discuss servicing tractors, trailers, and other machinery.
- Discuss service procedures for small 2-cycle and 4-cycle engines.
- Invite an auto mechanic to talk to the class about the importance of maintenance on vehicles.
- Invite a lawn equipment mechanic to show students how to service 2-cycle and 4-cycle engines. Have them discuss the importance of preventive maintenance.
- Demonstrate t[illegible]dents how to change fan belts.

Objectives 9 and 10

- Discuss the importance of keeping accurate service records.
- Discuss the necessity of having a clean work and delivery area.

APPLICATION

Objective 11

- Use Assignment Sheet 1 to teach students how to keep records on maintenance and service of equipment.

Objective 12

- Use Assignment Sheet 2 to give students the opportunity to plan a work schedule for cleaning the greenhouse and other work related areas.

Objective 13

- Use Job Sheet 1 to allow students the opportunity to change a fan belt.

EVALUATION

Practical Test

- *Explain to students that they will be asked to demonstrate* procedures on the job sheets to complete the practical test.
- Describe the rating scale used on the practical test.
- Give practical test.
- Reteach and retest if necessary.

Written Test

- Explain to students that they will be asked to demonstrate on the written test actions listed in the specific objectives.
- Give written test.

  NOTE: Written test may be given in sections if desired.
- Evaluate students on assignment sheet activities if not previously done.
- Reteach and retest if necessary.
- Complete the appropriate section of competency profiles.
- Review individual and group performance in order to evaluate teaching methods. Adjust scope, sequence, or instructional approaches for additional lessons as required.

SUGGESTED RESOURCES

Audiovisual Materials

- *Hand Safety*, 1/2" VHS, Color, 18 min., Tel-A-Train, 1987. Available from Tel-A-Train, 309 N. Market Street., Chattanooga, TN 37405, 615-624-2628.
- *Power and Hand Tool Safety*, 1/2" VHS, Color, 21 min., Tel-A-Train, 1987. Available from Tel-A-Train, 309 N. Market St., Chattanooga, TN 37405, 615-624-2628.

- *Eye Safety*, 1/2" VHS, Color, 20 min., Tel-A-Train, 1987. Available from Tel-A-Train, 309 N. Market St., Chattanooga, TN 37405, 615-624-2628.

NOTE: These videos are available to Oklahoma teachers on a free-loan basis. Oklahoma teachers may order these videos from the Oklahoma Department of Vocational and Technical Education, Resource Center, ATTN: Instructional Media Specialist, 1500 West Seventh Avenue, Stillwater, OK 74074, 1-800-522-5810. Out-of-state teachers must order from the addresses listed with each video.

UNIT REFERENCES

- Ball, Vic, *Ball Redbook*, 14th ed., Reston Publishing Company, Inc., Reston, Virginia, 1985.
- Laurie, Alex et al., *Commercial Flower Forcing*, 8th ed., McGraw-Hill Inc., New York, New York, 1979.
- Nelson, Kennard S., *The Greenhouse Grower, A Career in Floriculture*, The Interstate Printers and Publishers, Inc., Danville, Illinois, 1977.
- Nelson, Paul V., *Greenhouse Operation and Management*, 3rd. ed., Reston Publishing Company, Inc., Reston, Virginia, 1985.
- Williams, Sandra P., *Introduction to Horticulture*, Curriculum and Instructional Materials Center, Oklahoma Department of Vocational and Technical Education, Stillwater, Oklahoma, 1990.

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BASIC ACADEMIC SKILLS

The following table identifies the basic academic skills that are reinforced in this unit of instruction. These basic academic skills were identified using *The Basic/Essential Skills Taxonomy*, 2nd edition, and verified during the validation process.

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 1	Language Arts 132	Comprehends	Information-written	
	Language Arts 038	Collects/ Organizes	Information-Oral/written	
OBJECTIVE 2	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
OBJECTIVE 3	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity
OBJECTIVE 4	Language Arts 013	Applies/Uses	Definitions	
	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 5	Language Arts 013	Applies/Uses	Definitions	
	Language Arts 139	Comprehends	Information-written	Context
OBJECTIVE 6	Language Arts 098	Composes/ Edits	Reports/ essays	Summaries
OBJECTIVE 7	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity
OBJECTIVE 8	Language Arts 132	Comprehends	Information-written	
	Language Arts 038	Collects/ Organizes	Information-Oral/written	
OBJECTIVE 9	Language Arts 132	Comprehends	Information-written	
	Language Arts 038	Collects/ Organizes	Information-Oral/written	
OBJECTIVE 10	Language Arts 139	Comprehends	Information-written	Context
OBJECTIVE 11	Language Arts 058	Composes/ Edits	Forms/ documents	
OBJECTIVE 12	Language Arts 048	Composes/ Edits	Agenda	
OBJECTIVE 13	Language Arts 035	Attends	Directions/ task	

INFORMATION SHEET

SERVICING AND MAINTAINING EQUIPMENT

XIV

OBJECTIVE 1

List the major maintenance points for greenhouse fans.

Some type of fan is constantly running in the greenhouse; heater blowers in the winter, exhaust fans in the summer and air circulators the remaining months of the year. Greenhouse fans must be maintained and kept in good working condition.

- Examine pulleys for cracks or slippage; repair or replace as needed.
- Check alignment of fan and motor pulleys. Improper alignment ruins belts rapidly.
- Determine if the motor is securely mounted; replace any broken motor mounts.
- Inspect fan blades for cracks. Make sure the shaft supporting the fan blade is securely fastened.
- Lubricate any moving parts or ball bearings, if applicable.
- Check belts for cracks or wearing; replace as needed. A belt should have about 1/4" of slack when properly fitted.

OBJECTIVE 2

State required maintenance procedures for a greenhouse cooling system.

The evaporative cooling system in a greenhouse represents a major expense. Crossfluted cellulose pads can last up to seven years if they are properly cared for. However, these pads can last for as little as two years if they are not correctly maintained.

- Adjust the flow rate from the sump pump so the pad is kept wet.

  NOTE: Dry spots reduce the cooling efficiency and cause salts to accumulate.

- Check the distribution pipe for clogs.
  - Flush the distribution pipe once a month and open any clogged holes.

- Prevent algae from growing on the pad.
    - Add a biocide made for cooling systems to the sump once every two weeks.
- Prevent salt build up on the pads by using a valve to constantly bleed off a small amount of water from the distribution pipe.

  NOTE: This siphoning off of water will prevent salt build up.

- Keep pH of the sump solution between 6.0 and 9.0.

  NOTE: A solution of incorrect pH will cause the rapid destruction of the cellulose pads.

- Drain the sump and hose it out once a month during the summer.

  NOTE: Dirt accumulates in the sump solution and could clog the pads with continued use.

- Hose off the exterior surface of the cellulose pads once a month with moderate water pressure.

  NOTE: This removes any mud that has formed on the outside surface of the pads and opens clogged air passages.

- Lubricate ventilation shutters and motors as recommend by the manufacturer.
- Adjust vent shutters or doors as necessary for proper opening and closing.
- Lubricate sump pump as recommended by the manufacturer.

OBJECTIVE 3

Select from a list true statements concerning maintenance of automatic watering systems.

- Automatic watering systems save growers tremendous amounts of time when watering crops. Most of these systems will last at least five years if they are properly maintained.
- Use a 200 mesh screen to filter the water before it enters the automatic watering system.
- Clean the screen once a week.

- Open clogged emitters by tapping them on a solid object while the water is on; use a straight pin if tapping fails.

- Plug leaks by adjusting the spaghetti tube; install a new tube if necessary.

- Sterilize the header and spaghetti tubes every six months by pumping a disinfectant solution through the lines. Let the tubes sit for 20 minutes after pumping the disinfectant solution and then thoroughly rinse with plain water.

  NOTE: Disinfectant solution cannot contact plants or growing media, it is harmful to plant growth.

- Sterilize capillary mats every six months by drenching with a disinfectant solution and rinsing 20 minutes later.

- Capillary mats and soaker type hoses will develop algae build up.

  NOTE: Rinse all algaecide from a watering system before using.

- Remove mineral deposits from emitters by pumping a dilute phosphoric acid solution through the system. Thoroughly rinse the acid from the system before use.

OBJECTIVE 4 **Distinguish between service and maintenance of sprayers.**

The objective of preventive maintenance is to eliminate the downtime and repairs of equipment.

Maintenance of a sprayer involves the proper use and storage of equipment; service is the repairing of defective or broken parts.

- **Maintenance includes**
  - Using a strainer when filling the sprayer
  - Using the correct amount of pressure while spraying
  - Cleaning after each use
  - Drying the sprayer before storing
  - Storing under the proper conditions
  - Winding the cord after use
  - Attaching the battery charger after use

- **Service includes**
  - Replacing split, cracked or clogged hoses
  - Cleaning a clogged nozzle
  - Replacing seals, gaskets or belts
  - Installing a new nozzle
  - Replacing the electrical cord or battery
  - Lubricating wheels or rollers

OBJECTIVE 5 **Complete statements about the maintenance of hand tools.**

- Keep tools clean.
  - Wash after each use. Thoroughly dry the tools and lightly oil before storage.
  - A mixture of 60% sand and 40% motor oil is useful on garden tools. Wash a hoe or rake and then push it in and out of the sand/oil mixture; store with the sand on the tools, this prevents rust. A five gallon bucket with a lid is a good storage container for the sand/oil mixture.
- Keep all tools sharp.
  - More accidents occur with dull tools than do with sharp tools.
- Store tools in the designated area.
  - Knives, pruners, and scissors should be placed in a drawer.
  - Hang larger tools like hoes, rakes and loppers.
  - Always put tools where they belong; if an item is where it is suppose to be everyone will be able to find it.
- Use the proper tool for the job.
  - Accidents are more likely to occur when a person tries to do a job with the wrong tool. Don't try to cut a 2" rose cane with a knife - get pruners!

- Keep tools in safe working condition.
  - Throw away broken items that cannot be repaired.
  - Quickly repair broken or damaged tools if possible.
  - Inspect for loose screws, bolts or rough metal.
  - Lubricate moving parts to insure free movement.
  - Make sure locking devices work and that safety features remain operational.

OBJECTIVE 6

Describe service procedures for business vehicles.

Delivery trucks and vans are the main tool for selling greenhouse products. These vehicles are usually driven 6 days a week and accumulate lots of miles. The vehicle must be in top running condition so drivers can safely make their delivery routes.

- Assign one person to the servicing of vehicles.
  - It is their responsibility to see that preventive maintenance and service is done when needed.
- A weekly check of the following should be done and corrections made if needed.
  - Oil level
  - Radiator fluid
  - Air pressure in tires
  - Fluids (brake, transmission, power steering, windshield washer)
  - Belts and hoses
  - Lights and signals
  - Freon during warm weather
- Instruct drivers to check the oil level every time the vehicle is filled with fuel.

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- Follow recommended service procedures that are listed in the operator's manual.
    - Change oil and filter every 5000-7500 miles
    - Flush radiator once every two years
    - Rotate tires every six months or 5000 miles
    - Replace air filter every 10,000 miles
- Wash vehicles weekly so they appear neat and clean.
- Listen to the drivers when they have a comment.
    - Drivers spend a lot of time in the vehicles and are familiar with them.

OBJECTIVE 7 **Select from a list true statements about servicing tractors, trailers and other machinery.**

- Equipment runs as well as the care it receives. Greenhouse equipment like tractors, tillers and soil mixers should be cared for the same as any other business vehicle.
- Assign a specific person to be responsible for their upkeep. Often it will be the same employee who services the delivery vehicles.
- Follow service procedures recommended in the operator's manual.
- Check the oil, radiator fluid and tire pressure on a weekly basis.
- Change the oil and filter and lubricate the bearings according to the operator's manual.
- Clean equipment at least monthly to present a professional image.

OBJECTIVE 8 **List the major service procedures for small 2-cycle and 4-cycle engines.**

- 2-cycle engines
  - Change the spark plug at the beginning of the season of use.

    NOTE: Check the operator's manual to be sure the correct plug and plug setting is used. 2-cycle engines will need plug replacement more frequently than 4-cycle engines.
  - Install a new air filter at the start of the heavy use period.

    NOTE: Check the air filter weekly during heavy use. Many 2- and 4-cycle engines have a sponge type air filter that can be washed out with soapy water, treated with a small amount of oil and reused. Frequency of filter replacement will depend on how often the engine is used and under what conditions. Check the operator's manual.
  - 2-cycle engines require the gas and oil to be mixed together. Use the recommended type of oil at the correct mixing ratio.
- 4-cycle engines
  - Change spark plug at the beginning of the season of heavy use.

    NOTE: Check the operator's manual for the correct plug and setting.
  - Change the oil at the beginning of the season of heavy use.

    NOTE: Use the type of oil recommended in the operator's manual. If the engine receives heavy use, change the oil on a monthly basis.
  - Check the muffler.

    NOTE: Heavy use will quickly destroy the muffler. It may need to be replaced every eight weeks. Always keep a functioning muffler on the engine to reduce noise and prevent damage to the engine.
  - Drain gasoline from an engine before it is put into storage.

OBJECTIVE 9

List important information that should be recorded on service reports.

Service reports allow the maintenance person to keep track of what has been done to a vehicle or piece of equipment, and when it was done.

- Service records should include the following:
  - Date of repair or service
  - Vehicle or equipment that was serviced
  - Mileage or hour reading, if applicable
  - Service that was performed
  - List of materials and parts used
  - Miscellaneous information column
  - Person who did the service
- A small greenhouse can keep all service records together in one book.
- A larger greenhouse may have a specific service sheet for each vehicle or piece of equipment in the service book.
- Complete service records as soon as the service and maintenance procedure is done.

OBJECTIVE 10

Complete statements about cleaning the work and delivery areas.

- A clean work and delivery area is a safe place to work.
  - Accidents are more likely to occur if the work area is cluttered with trash and unnecessary items.
- Motivation is increased if employees have a neat area in which to work.
  - A job will be done with accuracy and enthusiasm if employees have plenty of room to work.
- Trash should be dumped at the end of each day.
  - If large amounts of trash accumulate during the day empty the trash containers when they become full.

  - Rinse trash containers once a week.

- Sweep the floor daily to remove the day's debris.
  - Once a week thoroughly sweep the entire work and delivery area.

- Put tools and supplies away when a job is finished. All tools should be stored in their proper location at the end of the day.

- Seedlings or cuttings that did not get transplanted should be returned to the greenhouse at the end of the day.

- Return plants that were not used in the delivery area to the greenhouse.

- The potting bench should be swept off at the end of each day. Excess growing media should be collected in a pile on the potting bench and left for tomorrow's use.

- Paperwork for the day should be completed and placed in the correct location or turned in to office personnel.

- Delivery trucks should be cleaned from the day's deliveries before new products are loaded.

ASSIGNMENT SHEET 1

SERVICING AND MAINTAINING EQUIPMENT

XIV

NAME ______________________________ SCORE _______

OBJECTIVE 11

Design a service record form.

INTRODUCTION

Service records are important to the proper upkeep of all vehicles and machinery. It is easy to make excuses for not writing things down; we all say "I'll remember" and three months later we can't remember. Train your employees, and yourself, to complete service records immediately when the job is finished.

Having an easy to read service record form will improve your chances of getting these records completed by employees.

DIRECTIONS

Using the information in Objective 9, design a typical service record form for your greenhouse on a separate sheet of paper. Make sure the titles are easy to read, there is enough room for employees to write, and all important information is collected.

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NAME ______________________________ SCORE _______

OBJECTIVE 12 **Create a schedule for cleaning the greenhouse and work area.**

INTRODUCTION Numerous small jobs must be done at a greenhouse. The best way to get the jobs done is to make a list of the tasks to be done and assign them to greenhouse employees.

DIRECTIONS Walk through your school's greenhouse, headhouse, grounds and work area and create a list of all the cleaning jobs that must be done. Make two lists; one for daily tasks and the second for weekly jobs.

Daily	Weekly
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________

SERVICING AND MAINTAINING EQUIPMENT

ASSIGNMENT SHEET 1

Use the following criteria for evaluation:

- The sheet should be divided into columns.
- Writing should be neat and easy to read.
- Headings should include:
    - Date
    - Vehicle or equipment serviced
    - Mileage
    - Procedure done
    - Materials and parts used
    - Miscellaneous information
    - Person who did the servicing
- The student can design a sheet to be used on all vehicles and machinery or they can design a sheet for a specific vehicle or piece of equipment.

ASSIGNMENT SHEET 2

Use the following criteria for evaluation:

- The daily work sheet should include tasks such as:
    - Dump trash.
    - Put plants back in greenhouse.
    - Sweep major work areas.
    - Lock up greenhouse and work area.
    - Put tools and supplies away.
    - Complete paperwork.

- The weekly work sheet should include tasks such as:
  - Rinse trash containers.
  - Thoroughly sweep entire work area.
  - Clean bathrooms.
  - Dump trash cans in the greenhouse.
  - Hose down greenhouse aisles.

JOB SHEET 1

SERVICING AND MAINTAINING EQUIPMENT

XIV

OBJECTIVE 13

Demonstrate the ability to change a fan belt.

INTRODUCTION

A greenhouse employee should be able to quickly replace a broken or slipping belt on a fan.

EQUIPMENT AND SUPPLIES

- New belt for fan

PROCEDURE

1. Shut off electricity to the fan.
2. Remove old belt if still in place.
   a. Grasp the belt near where it fits into the large pulley and gently roll the belt toward you.
   b. Carefully turn the large pulley so the belt rolls off the large pulley.
   c. Lift the belt off the small pulley.
3. Place the new belt around the small pulley so it fits properly into the track.
4. Put the new belt on the large pulley.
   a. Pull the new belt toward the large pulley.
   b. Place a small section of the belt in the track on top of the large pulley.
   c. Carefully, and slowly, turn the large pulley clockwise while guiding the new belt into the track.
   d. Keep turning the large pulley until the belt fits completely in the track of the pulley.
   e. Make sure your fingers do not get pinched between the belt and the pulley.
5. Check the belt for correct tension after it is installed.
   a. Push downward on the top part of the belt half way between the two pulleys. The belt should only move 1/4" or less.

   b. If the belt moves more than 1/4" it is too loose. Either use a smaller belt or adjust the tension on the belt.

6. Spin the large pulley several times to make sure the belt is properly installed.

7. Check the alignment of the pulleys.

   a. Lean close to the large pulley and look down the belt toward the small pulley. The two pulleys should be in a straight line from each other.

   b. If the line of sight is crooked, adjust one of the pulleys so they are aligned. Misaligned pulleys will unevenly wear belts and shorten their life.

8. Make sure all parts are securely in place.

9. Turn on the electricity to the fan.

10. Put away equipment and supplies and clean work area.

PRACTICAL TEST 1

SERVICING AND MAINTAINING EQUIPMENT

XIV

JOB SHEET 1

Demonstrate the ability to change a fan belt.

Student's name ____________________________ Date ____________

Evaluator's name ____________________________ Attempt no. _____

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and complete this form. All items listed under "Process Evaluation" must receive a "Yes" for you to receive an overall performance evaluation.

PROCESS EVALUATION

Evaluator note: Write a check mark in the "Yes" or "No" blanks to designate whether or not the student has satisfactorily achieved each step in this procedure. If the student is unable to achieve this competency, have the student review the materials and try again.

The student:	YES	NO
1. Shut off electricity to the fan.	______	______
2. Removed old belt if still in place.	______	______
a. Grasped the belt near where it fits into the large pulley and gently rolled the belt toward them.	______	______
b. Carefully turned the large pulley so the belt came off the large pulley.	______	______
c. Lifted the belt off the small pulley.	______	______
3. Placed the new belt around the small pulley so it fitted properly into the track.	______	______
4. Put the new belt on the large pulley.	______	______
a. Pulled the new belt toward the large pulley.	______	______
b. Placed a small section of the belt in the track on top of the large pulley.	______	______
c. Carefully, and slowly, turned the large pulley clockwise while guiding the new belt into the track.	______	______
d. Kept turning the large pulley until the belt fit completely in the track of the pulley.	______	______
e. Made sure their fingers did not get pinched between the belt and the pulley.	______	______

The student:	YES	NO
5. Checked the belt for correct tension after it was installed.	___	___
a. Pushed downward on the top part of the belt half way between the two pulleys. The belt should only move 1/4" or less.	___	___
b. If the belt moved more than 1/4" it was too loose. They either used a smaller belt or adjusted the tension on the belt.	___	___
6. Spun the large pulley several times to make sure the belt was properly installed.	___	___
7. Checked the alignment of the pulleys.	___	___
a. Leaned close to the large pulley and looked down the belt toward the small pulley. The two pulleys should be in a straight line from each other.	___	___
b. If the line of sight was crooked, adjusted one of the pulleys so they were aligned. Misaligned pulleys will unevenly wear belts and shorten their life.	___	___
8. Made sure all parts were securely in place.	___	___
9. Turned on the electricity to the fan.	___	___
10. Put away equipment and supplies and cleaned work area.	___	___

EVALUATOR'S COMMENTS

____

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See performance evaluation key). A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Old belt safely removed	4	3	2	1
Belt properly installed	4	3	2	1
Tension adjusted correctly	4	3	2	1
Belt properly aligned	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the competency profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 - Skilled—Can perform job with no additional training

3 - Moderately skilled—Has performed job during training program; limited additional training may be required

2 - Limited skill—Has performed job during training program; additional training is required to develop skill

1 - Unskilled—Is familiar with process; but is unable to perform job

WRITTEN TEST

SERVICING AND MAINTAINING EQUIPMENT

XIV

NAME ______________________ SCORE ________

OBJECTIVE 1

List the major maintenance points for greenhouse fans. Write the six major maintenance points in the space provided.

OBJECTIVE 2

State required maintenance procedures for a greenhouse cooling system. Write five areas of inspection when maintaining a greenhouse cooling system in the space provided.

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OBJECTIVE 3

Select from a list true statements concerning maintenance of automatic watering systems. Write an "X" in the blank before each true statement.

____ 1. Most automatic watering systems have a life expectancy of one to two years.

____ 2. A 300 mesh screen should be used in the water line of an automatic watering system.

____ 3. Clean the screen of an automatic watering system once a week.

____ 4. Clogged emitters can usually be opened by tapping them on a hard surface.

____ 5. Sterilize spaghetti tubes every six weeks by pumping a disinfectant solution through the lines.

____ 6. Capillary mats can be sterilized by drenching them with a disinfectant solution.

____ 7. Mineral deposits can be removed by pumping a lime solution through the system.

OBJECTIVE 4

Distinguish between service and maintenance of sprayers. Write an "S" in the blank before statements that are related to the servicing of sprayers and an "M" in the blank of statements that deal with maintenance.

____ 1. Replacing seals or gaskets

____ 2. Cleaning after use

____ 3. Replacing the electrical cord or battery

____ 4. Replacing split, cracked or clogged hoses

____ 5. Using a strainer when filling the sprayer

____ 6. Using the correct amount of pressure

____ 7. Lubricating wheels or rollers

____ 8. Cleaning clogged nozzles

____ 9. Attaching the battery charger after use

___ 10. Replacing a belt

OBJECTIVE 5

Complete statements about the maintenance of hand tools. Write the correct words in the blanks.

1. Keep tools__________________________.
2. A mixture of 60% sand and 40% oil can be used to prevent garden tools from ____________________.
3. More accidents occur because of _____________ tools.
4. Knives, pruners and scissors should be stored in a ________ and large tools should be ________ up.
5. Always put tools where they__________________ .
6. Use the proper ________________ for the job.
7. Keep tools in ________________________ working condition.
8. ______________________ moving parts to insure free movement.
9. Make sure safety features remain_____________ .
10. ________________away broken tools that are not repairable.

OBJECTIVE 6

Describe service procedures for business vehicles. List what procedures should be done and how often.

Engine oil

____

____

____

Fluids (brake, transmission, windshield washer)

____

____

____

Radiator fluid

____

____

____

Belts and hoses

Rotate tires

OBJECTIVE 7

Select from a list true statements about servicing tractors, trailers and other machinery. Write an "X" in the blank before each true statement.

____ 1. Each greenhouse employee is responsible for the service of any piece of machinery they use.

____ 2. Equipment runs as well as the care it receives.

____ 3. A service person should develop their own schedule of machinery service.

____ 4. Dirty equipment presents a professional image because it appears well used.

____ 5. Oil and filter changes along with lubrication of the bearings should be done according to the operator's manual.

OBJECTIVE 8

List the major service procedures for small 2-cycle and 4-cycle engines.

1. List the service procedures for a 2-cycle weedeater engine.

2. List the service procedures for a 4-cycle lawnmower.

OBJECTIVE 9

List important information that should be recorded on service reports. Write the seven major pieces of information needed in the space provided.

____

____

____

____

____

____

____

____

OBJECTIVE 10

Complete statements about cleaning the work and delivery areas. Write the correct words in the blanks.

1. Accidents are more likely to occur if the work area is __________________ .
2. A clean work area is a ______________ place to work.
3. Trash should be dumped at the end of each ________.
4. Sweep the floor ___________ .
5. Put tools and supplies away when a job is _________ .
6. Return plants or seedlings that were not needed to the ______________ at the end of the day.
7. Delivery trucks should be ________________ before they are loaded for the next day's deliveries.
8. Paperwork should be _______________at the end of each day and filed or given to office personnel.
9. Thoroughly sweep the entire work and delivery area once a ______________.
10. Employee __________________ will be increased if they have a neat area to work in.

NOTICE The following assignment sheets and job sheet are not part of the written test. If these activities have not been completed, check with your instructor.

OBJECTIVE 11 Design a service record form. SCORE ________

OBJECTIVE 12 Create a schedule for cleaning the greenhouse and work area. SCORE ________

OBJECTIVE 13 Demonstrate the ability to change a fan belt. RATING_______

OBJECTIVE 1

Answer should include:

- Examine pulleys for cracks or slippage.
- Check pulley alignment.
- Determine if motor is securely mounted.
- Inspect fan blades for cracks.
- Lubricate moving parts and bearings.
- Check belts for cracks or wear.

OBJECTIVE 2

Answer should include any five of the following:

- Adjust flow rate from sump pump.
- Check distribution pipe for clogs.
- Prevent algae from growing on the pad.
- Prevent salt build up on the pads.
- Keep pH of sump solution between 6.0 and 9.0.
- Drain sump once a month and hose it out.
- Hose off exterior surface of the pad once a month.
- Lubricate vent shutters and motors.
- Adjust vent shutters or door for proper opening and closing.
- Lubricate sump pump as recommended by manufacturer.

OBJECTIVE 3

3, 4, 6

OBJECTIVE 4

1. S
2. M
3. S
4. S
5. M
6. M
7. S
8. S
9. M
10. S

OBJECTIVE 5

1. Clean
2. Rusting
3. Dull
4. Drawer, hung
5. Belong
6. Tool
7. Safe
8. Lubricate
9. Operational
10. Throw

OBJECTIVE 6

Answers should include the following:

Engine oil

- Drivers check each time fuel is purchased.
- Service person checks once a week.
- Change oil and filter every 5000 to 7500 miles.

Fluids (brake, transmission, windshield washer)

- Check weekly and fill as needed.
- Change fluids according to operator's manual.

Radiator fluid

- Check weekly and fill as needed.
- Flush radiator and fill with new fluid once every two years.

Belts and hoses

- Check weekly.
- Change when they appear worn or cracks are seen.

Rotate tires

- Every six months or 5000 miles.

OBJECTIVE 7 2, 5

OBJECTIVE 8

1. Answer should include the following:
   - Change plug
   - Clean air filter or install a new one
   - Check oil and gas mixture (ratio and type)
2. Answer should include the following:
   - Change plug
   - Change oil
   - Change air filter
   - Check muffler

OBJECTIVE 9

Answer should include the following:

- Date of service
- Vehicle serviced
- Mileage or hour reading
- Service performed
- List of materials and parts used
- Miscellaneous information
- Person who did the service

OBJECTIVE 10

1. Cluttered
2. Safe
3. Day
4. Daily
5. Finished
6. Greenhouse
7. Cleaned
8. Completed
9. Week
10. Motivation

OBJECTIVES 11-12 Refer to answers to Assignment Sheets 1 and 2.

OBJECTIVE 13 Refer to Practical Test for Job Sheet 1.

OBJECTIVE SHEET

MANAGING THE BUSINESS

XV

INTRODUCTION

There is a lot more to running a greenhouse than just growing plants! Someone must plan what crops will be produced and when they will be grown, how much money will be required to produce the crop and where it will come from, and how many employees will be needed to complete the job. In addition, the business must be able to recognize profitable crops and identify crops that are not profitable. Also, many government documents must be completed and submitted.

UNIT OBJECTIVE

After completing this unit, the student should have a working knowledge of the management skills required to successfully operate a commercial greenhouse. The student will demonstrate these competencies by completing the assignment sheets and written test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Select from a list true statements about accounting systems.
2. Select from a list true statements about establishing business policies.
3. Discuss the use of budgets in the greenhouse business.
4. Complete statements about presenting a credit plan.
5. Select from a list true statements about calculating cash flow.
6. Match parts of a financial statement to their descriptions.
7. Select from a list true statements about completing a loan application.
8. Discuss tax requirements as they apply to greenhouse businesses.
9. Calculate net worth.
10. Complete statements about employee work schedules.
11. List guidelines for employee training programs.
12. Discuss employee evaluation procedures.
13. Identify characteristics of a good supervisor.
14. Discuss factors involved in calculating payroll.

15. Discuss computer use in the greenhouse industry.

16. Calculate an employee's paycheck. (Assignment Sheet 1)

17. Prepare a production budget. (Assignment Sheet 2)

MANAGING THE BUSINESS

PREPARATION

- Obtain materials to supplement unit.

  NOTE: See Suggested Resources.

- Review instructional outline for this unit. Modify time frames to suit class needs and plan activities for each class period.
- Study the specific objectives to determine those you will cover in your presentation. Decide also which objectives should be taught to which students.
- Determine scope and sequence of objectives that you add. Design and develop support materials, including evaluation techniques, for additional objectives.
- Determine how you will schedule time for students to demonstrate competence in the required procedures.
- Make arrangements for guest speakers. Supply speakers with specific objectives and other appropriate sections of the unit.
- Make arrangements to tour a greenhouse that uses computers.

DELIVERY

Objectives 1 through 3

- Discuss setting up an accounting system. Stress the importance of good record keeping.
- Discuss establishing business policies.
- Discuss the use of budgets in the greenhouse. Illustrate the idea of budgets by comparing greenhouse budgets with personal budgets.

Objectives 4 through 6

- Discuss presenting a credit plan.
- Discuss calculating cash flow.
- Discuss financial statements.
- Invite a certified public accountant to discuss financial records and the importance of keeping good business records.

Objective 7

- Discuss loan applications.
- Invite a bank representative to class to discuss what lending institutions require for commercial loan applications.

Objectives 8 and 9

- Discuss tax requirements for greenhouse businesses.
- Discuss calculating net worth. Have students calculate their own net worth.

Objectives 10 through 12

- Discuss employee work schedules. Ask students who are employed what they like/dislike about their employer's scheduling.
- Discuss employee training programs and evaluation procedures. Ask students if they have ever gone through a training program and whether it was effective.
- Invite a greenhouse manager to class to discuss their business's procedure for orientating, scheduling, and evaluating employees.

Objective 13

- Discuss characteristics of a good supervisor.
- Show the video *Successful Supervision.*

Objective 14

- Discuss calculating payroll. Show students an example of a paycheck to illustrate taxes withheld.

Objective 15

- Discuss computer use in the greenhouse.
- Take the class on a tour of a commercial greenhouse that uses computers to manage the business. Have the greenhouse manager demonstrate to the class how the computers are used to help run the greenhouse.
- Invite the computer science instructor to class to discuss basic facts a person should know before purchasing a computer or computer software.

APPLICATION

Objectives 16 and 17

- Use Assignment Sheet 1 to give students practice in calculating employee payroll.
- Use Assignment Sheet 2 to give students practice in preparing a working budget for crop production.

EVALUATION

Written Test

- Explain to students that they will be asked to demonstrate on the written test actions listed in the specific objectives.
- Give written test.

NOTE: Written test may be given in sections if desired.

- Evaluate students on assignment sheet activities if not previously done.
- Reteach and retest if necessary.
- Complete appropriate section of competency profiles.
- Review individual and group performance in order to evaluate teaching methods. Adjust scope, sequence, or instructional approaches for additional lessons as required.

SUGGESTED RESOURCES

Audiovisual Materials

- *Successful Supervision.* 1/2" VHS; color, 60 min.; Oklahoma Department of Vocational and Technical Education. Four of the most important leadership skills for a competent supervisor to follow.

  NOTE: The above video is available to Oklahoma teachers on a free-loan basis. Oklahoma teachers may order this video from the Oklahoma Department of Vocational and Technical Education, Resource Center, ATTN: Instructional Media Specialist, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074, phone 1-800-522-5810.

UNIT REFERENCES

- Berninger, Louis, *Profitable Garden Center Management*, 2nd ed., Reston Publishing Co., Reston Virginia, 1982.
- *Employees: How to Find Them and Pay Them*, U.S. Small Business Administration, Washington, DC, 1989.

- Guerrieri, Donald et al., *Accounting*, Houghton Mifflin Company, Boston, Massachusetts, 1985.
- *How to Get Started With A Small Business Computer*, U.S. Small Business Administration, Washington, DC, 1987.
- Radics, Stephen P. Jr. et al., *Steps in Meeting Your Tax Obligations*, U.S. Small Business Administration, Washington, DC, 1982.
- *Record Keeping: Business Information*, U.S. Small Business Administration, Washington, DC, 1984.
- *Recordkeeping in Small Business*, U.S. Small Business Administration, Washington, DC, 1988.
- Shilt, Bernard A. et al., *Business Principles and Management*, South-Western Publishing Co., Cincinnati, Ohio, 1973.
- *Understanding Cash Flow*, U.S. Small Business Administration, Washington, DC, 1987.

BASIC ACADEMIC SKILLS

The following table identifies the basic academic skills that are reinforced in this unit of instruction. These basic academic skills were identified using *The Basic/Essential Skills Taxonomy*, 2nd edition, and verified during the validation process.

	SKILL AREA/ CODE	**VERB**	**LINK A**	**LINK B**
OBJECTIVE 1	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity
OBJECTIVE 2	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity
OBJECTIVE 3	Free Enterprise 009	Defines	Economic terms	Budget
	Free Enterprise 065	Describes/ Explains	Economic concepts	
	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
OBJECTIVE 4	Free Enterprise 063	Describes/ Explains	Economic concepts	Credit responsibilities
OBJECTIVE 5	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 6	Free Enterprise 006	Defines	Economic terms	
OBJECTIVE 7	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity
OBJECTIVE 8	Free Enterprise 116	Describes/ Explains	Taxation	
	Free Enterprise 099	Describes/ Explains	Insurance types	
OBJECTIVE 9	Language Arts 013	Applies/Uses	Definitions	
	Mathematics 034	Computes	Addition	Whole numbers
	Mathematics 092	Computes	Subtraction	Whole
OBJECTIVE 10	Language Arts 252	Infers/ Predicts	Information-written	Context
OBJECTIVE 11	Language Arts 132	Comprehends	Information-written	
	Language Arts 038	Collects/ Organizes	Information-oral/written	
OBJECTIVE 12	Language Arts 038	Collects/ Organizes	Information-oral/written	
	Language Arts 098	Composes/ Edits	Reports/ essays	Summaries

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 13	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity
OBJECTIVE 14	Free Enterprise 087	Describes/ Explains	Government impact/costs	
	Language Arts 098	Composes/ Edits	Reports/ essays	Summaries
OBJECTIVE 15	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
OBJECTIVE 16	Mathematics 015	Calculates	Percent	In/decrease, markup/ discount
	Mathematics 026	Computes	Addition	Decimals
	Mathematics 065	Computes	Multiplication	Decimals
	Mathematics 084	Computes	Subtraction	Decimals
	OR			
	Mathematics 261	Uses calculator	Addition	
	Mathematics 266	Uses calculator	Multiplication	
	Mathematics 268	Uses calculator	Subtraction	

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 17	Free Enterprise 128	Prepares	Personal Budget	
	Mathematics 026	Computes	Addition	Decimals
	OR			
	Mathematics 261	Uses calculator	Addition	

OBJECTIVE 1

Select from a list true statements about accounting systems.

The accounting system a business chooses must be easy to use and reliable. Keeping clear and precise records is very important to a successful business.

- Hire a professional accountant to help you set up your record keeping system. Accountants are familiar with many different types of systems and can select the one best suited to your business.
- Professional accountants know how to use financial information; the small business owner may not. The accountant will help you set up your daily record keeping system and then analyze the information at the end of each month.
- Choose an accountant with whom you communicate well. You will be working very closely with this person.
- When selecting an accountant consider the following:
  - Reputation
  - Experience and skills
  - Interest (are they familiar with agricultural businesses)
  - Fees
- Record keeping systems can be purchased at office supply or stationary stores, or your accountant may develop a personalized set of ledgers for your business.
- A professional accountant will save your business time, money and problems in the long run.
- The accounting system a busines chooses should be easy to use and reliable.

OBJECTIVE 2

Select from a list true statements about establishing business policies.

All greenhouse customers should be familiar with the business's policies before a transaction occurs. The greenhouse management should also be aware of the policies of its creditors. Prior knowledge of the "playing rules" eliminates problems in the future.

- Predetermine the policies your greenhouse will use to collect money from charge customers. Do not make special rules for each customer.

- Set return policies and make sure customers are aware of the policy.

- Will your business guarantee its products? Inform the customer of the policy at the time of sale.

- Decide if mass market or wholesale customers will be required to sign a contract when ordering large amounts of products for future sales.

  EXAMPLE: 6000 poinsettias ordered in May for December sales.

- Negotiate with lenders so loan payments will coincide with heavy sales periods.

  EXAMPLE: January and June loan payments.

- Talk with your suppliers and set up credit plans and payment schedules that both businesses agree upon. Most suppliers are anxious to help a new greenhouse become established.

OBJECTIVE 3

Discuss the use of budgets in the greenhouse business.

A budget is an estimated plan of what it is going to cost to complete a task.

- Budgets should be considered as rough working guides; they cannot be strictly followed.

- A separate budget should be developed for sales, advertising, supplies, labor and basic operating expenses.

- Use previous records and data along with inflation figures to estimate the current budget.

- Prepare budgets for the entire fiscal year on a month by month basis. Estimate the amount of supplies and labor the greenhouse will need each month. This figure will depend on what crops will be grown and on the volume of crops.

  EXAMPLE: More media and transplanters will be needed in March than in June. Projected sales and production cost will depend on the season of the year.

- Calculate a realistic budget. Many greenhouse managers prepare a tight budget that does not realistically estimate the needs of the greenhouse. Try to be as accurate as possible when estimating the budget requirements.

- Allow for unexpected expenses. Many greenhouse managers will budget a 10% reserve for unexpected expenses.

- A budget should itemize all expenses involved in completing the task. A labor budget will list number of employees budgeted for, salary, FICA, insurance, workmen's compensation, etc.

- Check your budget on a monthly basis and see how the actual expenditures compare to the predicted figures on the budget. If the greenhouse is over budget, expenses may need to be cut or additional funds will have to be found.

OBJECTIVE 4

Complete statements about presenting a credit plan.

- A credit plan is your projected cash needs to operate the business and the estimated income for the business. It shows the lender how your business will make money and be able to pay off creditors.

- Before talking with a banker you must have a lawyer and accountant already chosen.

- Have your accountant help you prepare all the necessary financial papers required by the bank.

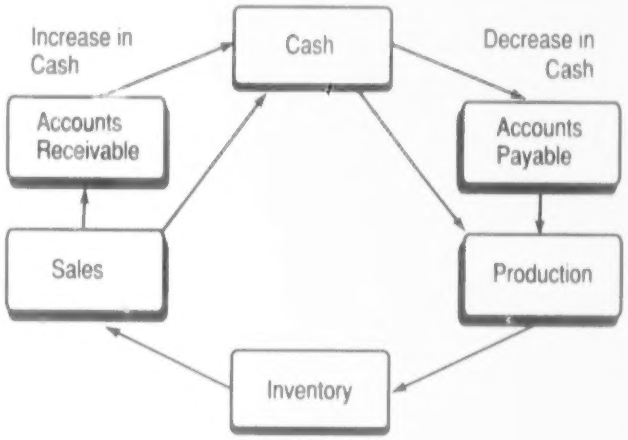
- Bankers do not like to see credit plans that underestimate the amount of money needed to buy or run a business. Many people think if they ask for a small amount of money the lender will be more likely to say yes to the loan. Lenders know how much it will take to buy or run a business and are not fooled by low figure credit plans.

- A poorly constructed credit plan shows a lack of professionalism and reliability.

- Lenders require a loan application, personal financial statement, net worth of the business and a three year budget for revenues and expenses for the business.
- Banks prefer that the person applying for the loan to personally invest in cash at least 20-25% of the loan. Banks are not likely to invest in a project if the loan applicant does not want to, or is personally unable to, invest in the project.
- Credit plans should be neatly prepared and as accurate as possible. A sloppy, partially completed credit plan will hurt your chances of securing financing.

OBJECTIVE 5 **Select from a list true statements about calculating cash flow.**

- Cash flow is the amount of money that goes through a business during a specific period of time.
- A business receives and spends cash every day.



- It is not a sin to ask for cash on delivery. A small greenhouse cannot afford the collection process.
- A successful business must have a positive cash flow to survive. A positive cash flow means more money is earned than what is spent; revenue exceeds expenses. Most new businesses fail due to negative cash flow; expenses exceed revenue and the business does not have enough cash reserve to continue operating.

- A greenhouse manager should estimate cash flow statements for a three to six month period, at least three months in advance. This allows the manager to see when the cash flow is expected to be negative and to plan for this cash shortfall.
- To determine cash flow, estimate all the expenses and revenue for each month and see if there will be a cash shortfall or cash excess.
- Sufficient cash must be available to produce the crops and run the greenhouse until the plants are ready for sale. Most bedding plant crops are started in January and February but greenhouse sales are very low during these months; reserve cash must carry the greenhouse through these months until the crops are sold. There is also a period of time between when plants are sold on credit and when the payment is received.
- Records from previous years are very helpful when estimating cash flow statements.
- A negative cash flow will require an increase in sales revenue, a decrease in expenses, or a combination of both. If income and expenses cannot be changed, the greenhouse manager must find cash from some other source for the business to survive.

OBJECTIVE 6

Match parts of a financial statement to their descriptions.

- Financial statements are reports that show changes in the finances of a business during a certain period of time, usually a month. Financial statements include an income statement, a statement of change in the owner's equity, and a balance sheet.

  - **Income statement**—Usually calculated at the end of every month; total revenue for the period minus expenses for the same period produce the income for the period. Shows the profit or loss for a specific period of time; is helpful in preparing estimated cash flow; at one time were called "profit-loss statements."

Computer World
Income Statement
For the Month Ended Feburary 29, 19__

Revenue:		
Fees Income		$1,650.00
Expenses:		
Maintenance Expense	$ 35.00	
Advertising Expense	300.00	
Rent Expense	540.00	
Utilities Expense	100.00	
Total Expenses		975.00
Net Income		**$ 675.00**

  - **Statement of a change in owner's equity**—Details the amount of money the owner has invested in the business; reflects any investments that have been withdrawn from the business.

  - **Balance sheet**—Shows the current balance in all asset and liability accounts; the total of all assets must equal the total of all liabilities on a balance sheet.

D. F. Homer
Balance Sheet
December 31, 19__

Assets			
Current assets:			
Cash		$ 5,345.69	
Accounts receivable		521.80	
Merchandise inventory		2,555.00	
Supplies		98.55	
Insurance		93.00	
Total current assets			$ 8,614.04
Fixed assets:			
Equipment		$14,700.00	
Less depreciation		1,643.90	
Total fixed assets			13,057.10
Total assets			$ 21,671.14
Liabilities			
Current liabilities:			
Accounts payable		$ 4,654.78	
Accrued wages payable		589.00	
Taxes payable		70.50	
Total current liabilities			$ 5,314.28
Long-term liabilities:			
Bank loan, 5-year			4,300.00
Total liabilities			$ 9,614.28
Proprietorship			
D. F. Homer, Capital, June 1		$11,482.50	
Net income for period	$3,567.40		
Less withdrawals	2,333.00		
Net increase in capital		2,325.50	
D. F. Homer, Capital, December 31			13,808.00
Total liabilities and proprietorship			$23,422.2

NOTE: This financial statement presents a good picture of the overall stability and health of a business.

OBJECTIVE 7

Select from a list true statements about completing a loan application. (Supplement 1)

- Loan applications are much like any other type of application form.
- Completely fill out the application. Do not leave items blank or unanswered.
- Write neatly and legibly.
- An accountant will usually be required to calculate many of the figures requested.
- Accurately and truthfully complete the form.
- Submit the loan application in a timely manner. Do not turn it in at the last moment.
- Prepare other required financial statements and submit them with the loan application. Do not submit an application without supporting materials.
- Be prepared to defend your application and proposed financial plan when you meet with the lender.

OBJECTIVE 8

Discuss tax requirements as they apply to greenhouse businesses.

Anybody running a business has to pay taxes. Not only does a business pay taxes, it also collects sales tax from customers and payroll tax from employees.

- A greenhouse must pay federal, state and local tax on any profit the business makes. The business must file a tax return with the government like any other wage earner. These forms are complicated and should be done by a certified public accountant.
- State and local sales taxes are collected from customers at the time of a sale. The greenhouse has to turn this money in to the proper government agency at specific times. Accountants know when these taxes are due and can fill out the necessary forms.
- Payroll taxes are made up of federal income tax, state income and social security tax (FICA). These taxes must be withheld from employees' paychecks. This money also has to be submitted to the government.

- Social security tax that is withheld from an employee's paycheck must also be matched by the employer. For every dollar that is withheld from an employee's paycheck the employer must also contribute that amount of money to the social security administration.
- Unemployment insurance and worker's compensation may also have to be paid by the business. Your accountant can tell you if your business has to pay these taxes.
- Each tax requires a separate form when submitting money to the government. This can be very confusing and complicated to a small business person.
- Due dates for the various taxes differ depending on the size of the business and how much tax is collected.
- Penalties are charged for filing late forms or if the forms are incorrectly completed. Accountants are trained in this type of work and are familiar with the deadlines, and they know if your business is entitled to any exemptions. A greenhouse will save money by not being charged late fees or penalties if an accountant is hired to do the tax work.
- Accountants save the greenhouse manager endless hours of paper work. This allows the manager to spend more time running the greenhouse.
- A certified public accountant is well worth the fee they charge.

OBJECTIVE 9

Calculate net worth.

- Net worth is a figure that indicates how much a person, or business, is worth after all debts are paid.
- Personal net worth is calculated by adding up the value of all assets and then subtracting the amount of all debts owed. The remaining figure is the net worth of that person.
- A business's net worth is calculated in the same manner as that of an individual. All liabilities are subtracted from total assets and the remaining figure is the net worth of the business.
- Bankers require a personal net worth statement from anyone seeking a loan.

- Bankers use personal net worth as collateral when considering loan applications.

OBJECTIVE 10 **Complete statements about employee work schedules.**

- Employees are one of the best assets of a successful business. Courteous, helpful employees will increase sales at a greenhouse, while dissatisfied employees discourage sales.
- Employee work schedules should be planned at least two weeks in advance. This allows the employees to know what days they are working and when they will be off.
- Planning the work schedule ahead of time allows employees to request special days off in the future.
- Try to prepare schedules so compatible employees work together. Two individuals may both be great workers but they may not work well together.
- Determine the number of employees needed for the job and schedule accordingly. Do not understaff or overstaff; it can frustrate employees and customers, and cost your business money.
- Assign specific jobs to each employee. One employee may be good at transplanting while another employee is a better salesperson. Matching the right employee to each task increases productivity and profits.

OBJECTIVE 11 **List guidelines for employee training programs.**

The difference between an average employee and an outstanding employee often depends on the training received. Time should be taken to teach new employees how a job is to be done. Training new employees takes place whether it is through a planned program or by trial and error. It is less expensive for the new employee to be properly trained from the start. The following are guidelines to follow in planning a training program:

- Assign new employees to work with established employees.

  NOTE: New employees are often more comfortable working with another employee than they are working with the supervisor. Make sure the "teacher" trains the new employee to use the correct procedures.

- Inform new employees of the reasons behind procedures.

  NOTE: Most people will follow standard procedures if they know why they are used.

- Limit the number of jobs for which a new employee is trained to two jobs a day.

  NOTE: New employees may become overwhelmed if too many tasks are presented at one time. They may not be able to learn any job correctly.

- Train new employees on simple tasks first and more complicated tasks later.

- Present new employees with a policies and procedures manual.

  NOTE: Correct procedures for completing each task should be itemized in a clear, concise manner.

- Monitor new employees closely as they learn new tasks.

  NOTE: New employees expect to receive constructive criticism. It is better to train correctly from the beginning than to correct their mistakes later.

- Train new employees during calm periods.

  NOTE: Do not attempt to train a new employee under stressful conditions.

- Create an atmosphere where employees may ask questions and make suggestions.

  NOTE: Employees who feel involved in the operation of the greenhouse will more likely be satisfied with their job and be more productive.

- Do not expect all employees to be trained at the same rate.

  NOTE: Some people learn more quickly than others. Employees should be trained for a new task only after they have successfully mastered the previous job.

OBJECTIVE 12

Discuss employee evaluation procedures.

Most employees want to do a good job. People who are challenged probably will enjoy their job and accept more responsibility; bored employees quickly become frustrated and lose interest in their job.

- The employee evaluation process should be considered as an evaluation of both the employee and the training they received.
- Poor employee performance may indicate poor employee orientation and training programs.
- Schedule periodic reviews of all employee's performances. Employees like to know how they are doing and how they can improve. Evaluations should be done at least once a year.
- Sit down alone with the employee and discuss his or her performance. Never evaluate an employee in front of other personnel.
- Many businesses develop a progress report form that is used to evaluate employee performance. A sliding scale of 1-5 (1=poor, 2=fair, 3=average, 4=good, 5=excellent) is used to rate employee performance. Areas of evaluation include courteousness, promptness, physical appearance, sales skills, knowledge of plant materials, transplanting skills, etc.
- Written comments should be included. Always make at least one positive comment on an employee's evaluation. If none can be made, the employee should not be working for the greenhouse.
- Use constructive criticism. Negative and/or humiliating comments will not motivate an employee to improve.
- Have an open dialogue between the supervisor and the employee. The employee may have some information or suggestions that could be useful.
- Reward employees for a good job. Compliment employees after they have done a good job or when they have made a special effort for someone; everyone likes to be praised. Many businesses periodically give out movie tickets, gift certificates to restaurants, or have company sponsored picnics to reward good employees. Salary increases are also used as rewards.

- Employees should sign and date their performance report after it has been discussed. This shows that the employee understands his or her evaluation, and it protects the employer from future legal problems.

OBJECTIVE 13

Identify characteristics of a good supervisor.

The following are characteristics which good supervisors should possess:

- The ability to motivate employees to perform to the best of their ability.
- The ability to create a pleasant working atmosphere.
- The ability to deal with many personalities.

  NOTE: Some employees must be dealt with sternly while others need only gentle guidance.
- A personal interest in each employee.

  NOTE: The supervisor should know enough about the employee to ask about their spouse or children. Employees usually respond well to a person who is genuinely interested in them.
- The ability to treat each employee with respect.

  NOTE: A supervisor should never treat an employee as a servant. Supervisors should never ask an employee to do something which they would not do themselves.
- The ability to listen to complaints or comments of employees.

  NOTE: Because the employees are the ones who do the jobs every day, they are often more familiar with problems than the supervisor and as a result may have excellent solutions.
- The ability to be understanding and compassionate when employees experience personal problems.

  EXAMPLES: Death of a family member, divorce, personal or family illness, problems with children
- Good judgement in knowing when to be stern and when to be lax.
- The ability to carry out the rule "treat employees as you would like to be treated."

OBJECTIVE 14

Discuss factors involved in calculating payroll.

(Supplements 2 and 3)

The greenhouse manager will be responsible for calculating employee payroll and withholding all necessary deductions.

- Every employee should fill out a federal W-4 form to inform employers of withholding deductions they have. Taxes will be withheld based on this withholding figure.
- Total the hours an employee has worked during the pay period.
- Multiply the number of hours worked by the hourly wage; be sure to calculate overtime pay if applicable. This figure is the employee's gross salary.
- Taxes and social security (also called FICA) must be withheld from the employee's gross salary.
- The current social security withholding rate is 7.65% of the gross salary. If an employee's gross salary is $647, $49.50 must be withheld from their paycheck and sent to the Social Security Administration. The employer must also send $49.50 because they are required by law to match whatever an employee contributes.
- Federal and state taxes are calculated by using charts provided by the government. Different charts will be used if the employee is single or married, and if they are being paid weekly or monthly. Make sure the correct chart is used for each employee.
- Locate the employee's gross salary in the left hand column on the tax chart and follow that line across the page. Locate the number of withholding allowances the employee is claiming across the top row and follow that column downward until it intersects the row containing the employee's salary. The point where the two lines intersect is the amount of tax withheld from the employee's paycheck.
- The example on the following page shows how to determine how much federal income tax should be withheld from the paycheck of an employee who earned a gross salary of $140 for a week, is single and has one withholding allowance.

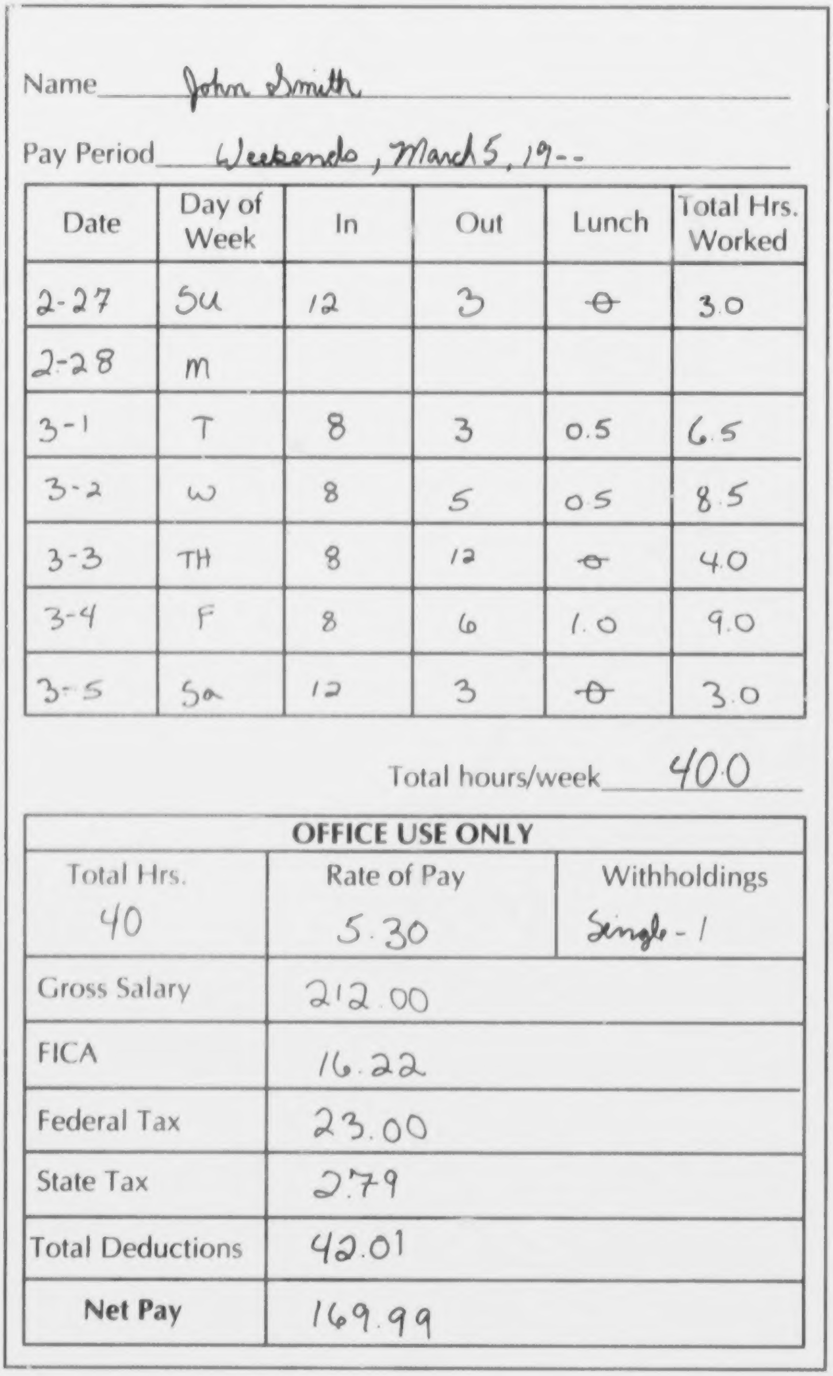
SINGLE Persons–**WEEKLY** Payroll Period

(For Wages Paid After December 1989)

And the wages are–		And the number of withholding allowances claimed is–										
At least	But less than	0	1	2	3	4	5	6	7	8	9	10
$0	$25	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
25	30	1	0	0	0	0	0	0	0	0	0	0
30	35	1	0	0	0	0	0	0	0	0	0	0
35	40	2	0	0	0	0	0	0	0	0	0	0
40	45	3	0	0	0	0	0	0	0	0	0	0
45	50	4	0	0	0	0	0	0	0	0	0	0
50	55	4	0	0	0	0	0	0	0	0	0	0
55	60	5	0	0	0	0	0	0	0	0	0	0
60	65	6	0	0	0	0	0	0	0	0	0	0
65	70	7	1	0	0	0	0	0	0	0	0	0
70	75	7	2	0	0	0	0	0	0	0	0	0
75	80	8	2	0	0	0	0	0	0	0	0	0
80	85	9	3	0	0	0	0	0	0	0	0	0
85	90	10	4	0	0	0	0	0	0	0	0	0
90	95	10	5	0	0	0	0	0	0	0	0	0
95	100	11	5	0	0	0	0	0	0	0	0	0
100	105	12	6	0	0	0	0	0	0	0	0	0
105	110	13	7	1	0	0	0	0	0	0	0	0
110	115	13	8	2	0	0	0	0	0	0	0	0
115	120	14	8	2	0	0	0	0	0	0	0	0
120	125	15	9	3	0	0	0	0	0	0	0	0
125	130	16	10	4	0	0	0	0	0	0	0	0
130	135	16	11	5	0	0	0	0	0	0	0	0
135	140	17	11	5	0	0	0	0	0	0	0	0
140	145	18	12	6	0	0	0	0	0	0	0	0
145	150	19	13	7	1	0	0	0	0	0	0	0
150	155	19	14	8	2	0	0	0	0	0	0	0
155	160	20	14	8	2	0	0	0	0	0	0	0
160	165	21	15	9	3	0	0	0	0	0	0	0
165	170	22	16	10	4	0	0	0	0	0	0	0
170	175	22	17	11	5	0	0	0	0	0	0	0
175	180	23	17	11	5	0	0	0	0	0	0	0
180	185	24	18	12	6	0	0	0	0	0	0	0
185	190	25	19	13	7	1	0	0	0	0	0	0
[illegible]	[illegible]	[illegible]	20	[illegible]	8	2	0	0	0	0	0	0

- In addition to the $12 in federal tax withheld, $10.71 in FICA must also be withheld.
- State governments also issue their own tax charts; they are used like the federal tax charts. Sometimes the state government suggests the employers withhold a specific percent of an employee's gross salary.

- The figure below shows the calculated payroll for employee John Smith. His paycheck for the week ending March 5 was $169.99.



Name John Smith

Pay Period Weekends, March 5, 19--

Date	Day of Week	In	Out	Lunch	Total Hrs. Worked
2-27	Su	12	3	0	3.0
2-28	M				
3-1	T	8	3	0.5	6.5
3-2	W	8	5	0.5	8.5
3-3	TH	8	12	0	4.0
3-4	F	8	6	1.0	9.0
3-5	Sa	12	3	0	3.0

Total hours/week 40.0

OFFICE USE ONLY		
Total Hrs. 40	Rate of Pay 5.30	Withholdings Single - 1
Gross Salary	212.00	
FICA	16.22	
Federal Tax	23.00	
State Tax	2.79	
Total Deductions	42.01	
Net Pay	169.99	

- The money withheld from an employee's check should be deposited into a separate checking account specifically for paying taxes. When it is time to pay taxes the payment check should be written from this account.
- Remember, the business must match the amount of FICA withheld from an employees payroll. Make sure to deposit the business' portion into the tax checking account.

OBJECTIVE 15 **Discuss computer use in the greenhouse industry.**

Computers can be used to help the greenhouse run more efficiently. Personnel must be trained in computer use and management must keep updated on computer developments.

- Computers and computer software can be used for many greenhouse functions. They can control the temperature, humidity, light intensity, sense the need for mist in the propagation house or water potted crops.
- Software programs are available that will calculate growing schedules and space requirements for crop production, keep track of inventory and determine sale prices.
- Software programs can be purchased that will do accounting procedures, mailing lists, newsletters, and calculate payroll.
- The first and most important step in buying a computer or computer software is to decide exactly what it will be used for, and then buy the hardware or software that fits that need. Many people buy hardware or software that is too small or too big for their needs. *Know your needs!*
- Make sure to plan for expansion during the next few of years. Will the hardware or software be usable if your business grows by 50% in two years?
- Talk with other growers who use computers and see what they like and don't like about their system. Ask them what they would get if they were buying today.
- Visit several computer stores and talk with the salespeople. Sit down and use their computer or software for at least 30 minutes. This helps you see how user friendly the system is.
- Have someone who is computer literate go with you when shopping for hardware or software.

- Find out what kind of technical service the company offers after the sale. Many companies have toll free numbers a customer can call to get help with questions they may have about the machine or software problems. This is a valuable service to a beginner.

- Also find out if the system can be upgraded or expanded easily in the future.

- Evaluate cost. Your business may not be able to afford everything you want initially. Can the system be upgraded or expanded easily in a year or so?

- Be realistic when planning for computer use. A computer does not solve all your business problems. If you have a terrible recordkeeping system a computer will not solve the problem.

- Take your time and make sure the hardware or software does what you want before you purchase it.

LOAN APPLICATION

OMB Approval No. 3245–0188
Exp. Date: 10–31–87

PERSONAL FINANCIAL STATEMENT

As of ________________ 19 ____

Complete this form if 1) a sole proprietorship by the proprietor; 2) a partnership by each partner; 3) a corporation by each officer and ch stockholder with 20% or more ownership; 4) any other person or entity providing a guaranty on the loan.

Name ____________________ Residence Phone ____________________

Residence Address ____________________

City, State, & Zip ____________________

Business Name of Applicant/Borrower ____________________

ASSETS	(Omit Cents)	LIABILITIES	(Omit Cents)
Cash on hand & in Banks	$	Accounts Payable	$
Savings Accounts		Notes Payable (to Bk & Others (Describe in Section 2)	
IRA		Installment Account (Auto) Mo. Payments $	
Accounts & Notes Receivable (Describe in Section 6)		Installment Account (Other) Mo. Payments $	
Life Insurance—Cash Surrender Value Only		Loans on Life Insurance	
Stocks and Bonds (Describe in Section 3)		Mortgages on Real Estate (Describe in Section 4)	
Real Estate (Describe in Section 4)		Unpaid Taxes (Describe in Section 7)	
Automobile—Present Value		Other Liabilities (Describe in Section 8)	
Other Personal Property (Describe in Section 5)		Total Liabilities	
Other Assets (Describe in Section 6)		Net Worth	
Total	$	Total	$

Section 1. Source of Income		Contingent Liabilities	
Salary	$	As Endorser or Co-Maker	$
Net Investment Income		Legal Claims & Judgments	
Real Estate Income		Provision for Fed Income Tax	
Other Income (Describe)*		Other Special Debt	

Description of Items Listed in Section I ____________________

*(Alimony or child support payments need not be disclosed in "Other Income" unless it is desired to have such payments counted toward total income.)

Section 2. Notes Payable to Banks and Others

Name & Address of Noteholder	Original Balance	Current Balance	Payment Amount	Terms (Monthly etc.)	How Secured or Endorsed—Type of Collateral

SBA Form 413 (10-86) Use 11-84 edition until exhausted Refer to SOP 50 10

(Response is required to obtain a benefit)

1990 Form W-4

Department of the Treasury
Internal Revenue Service

Purpose. Complete Form W 4 so that your employer can withhold the correct amount of Federal income tax from your pay

Exemption From Withholding. Read line 6 of the certificate below to see if you can claim exempt status *If exempt, complete line 6, but do not complete lines 4 and 5* No Federal income tax will be withheld from your pay This exemption expires February 15, 1991

Basic Instructions. Employees who are not exempt should complete the Personal Allowances Worksheet Additional worksheets are provided on page 2 for employees to adjust their withholding allowances based on itemized deductions, adjustments to income, or two earner/two job situations Complete all worksheets that apply to your situation The worksheets will help you figure the number of withholding allowances you are entitled to claim However, you may claim fewer allowances than this

Head of Household. Generally, you may claim head of household filing status on your tax return only if you are unmarried and pay more than 50% of the costs of keeping up a home for yourself and your dependent(s) or other qualifying individuals

Nonwage Income. If you have a large amount of nonwage income, such as interest or dividends, you should consider making estimated tax payments using Form 1040 ES Otherwise, you may find that you owe additional tax at the end of the year

Two-Earner/Two-Jobs. If you have a working spouse or more than one job, figure the total number of allowances you are entitled to claim on all jobs using worksheets from only one Form W 4 This total should be divided among all jobs Your withholding will usually be most accurate when all allowances are claimed on the W-4 filed for the highest paying job and zero allowances are claimed for the others

Advance Earned Income Credit. If you are eligible for this credit, you can receive it added to your paycheck throughout the year For details, obtain Form W-5 from your employer

Check Your Withholding. After your W-4 takes effect, you can use **Publication 919,** Is My Withholding Correct for 1990?, to see how the dollar amount you are having withheld compares to your estimated total annual tax Call 1-800-424-3676 (in Hawaii and Alaska, check your local telephone directory) to order this publication Check your local telephone directory for the IRS assistance number if you need further help

Personal Allowances Worksheet

A Enter "1" for **yourself** if no one else can claim you as a dependent A ______

B Enter "1" if
1. You are single and have only one job, or
2. You are married, have only one job, and your spouse does not work, or
3. Your wages from a second job or your spouse's wages (or the total of both) are $2,500 or less

B ______

C Enter "1" for your **spouse.** But, you may choose to enter "0" if you are married and have either a working spouse or more than one job (this may help you avoid having too little tax withheld) C ______

D Enter number of **dependents** (other than your spouse or yourself) whom you will claim on your tax return D ______

E Enter "1" if you will file as a **head of household** on your tax return (see conditions under "Head of Household," above) E ______

F Enter "1" if you have at least $1,500 of **child or dependent care expenses** for which you plan to claim a credit F ______

G Add lines A through F and enter total here ▶ G ______

For accuracy, do all worksheets that apply
- If you plan to **itemize or claim adjustments to income** and want to reduce your withholding, turn to the Deductions and Adjustments Worksheet on page 2
- If you are **single** and have **more than one job** and your combined earnings from all jobs exceed $25,000 OR if you are **married** and have a **working spouse or more than one job,** and the combined earnings from all jobs exceed $44,000, then turn to the Two-Earner/Two-Job Worksheet on page 2 if you want to avoid having too little tax withheld
- If **neither** of the above situations applies to you, **stop here** and enter the number from line G on line 4 of Form W-4 below

Cut here and give the certificate to your employer. Keep the top portion for your records.

Form **W-4**
Department of the Treasury
Internal Revenue Service

Employee's Withholding Allowance Certificate

▶ **For Privacy Act and Paperwork Reduction Act Notice, see reverse.**

OMB No 1545-0010
1990

1 Type or print your first name and middle initial | Last name | 2 Your social security number

Home address (number and street or rural route)

City or town, state, and ZIP code

3 Marital status ☐ Single ☐ Married
☐ Married, but withhold at higher Single rate
Note: *If married, but legally separated, or spouse is a nonresident alien, check the Single box*

4 Total number of allowances you are claiming (from line G above or from the Worksheets on back if they apply) 4 ______

5 Additional amount, if any, you want deducted from each pay 5 $ ______

6 I claim exemption from withholding and I certify that I meet **ALL** of the following conditions for exemption
- Last year I had a right to a refund of **ALL** Federal income tax withheld because I had **NO** tax liability, **AND**
- This year I expect a refund of **ALL** Federal income tax withheld because I expect to have **NO** tax liability, **AND**
- This year if my income exceeds $500 and includes nonwage income, another person cannot claim me as a dependent

If you meet all of the above conditions, enter the year effective and "EXEMPT" here ▶ 6 19 ______

7 Are you a full-time student? (**Note:** *Full-time students are not automatically exempt.*) 7 ☐ Yes ☐ No

Under penalties of perjury, I certify that I am entitled to the number of withholding allowances claimed on this certificate or entitled to claim exempt status

Employee's signature ▶ ______ **Date** ▶ ______ 19 ______

8 Employer's name and address (**Employer:** Complete 8 and 10 **only if sending to IRS**) | **9** Office code (optional) | **10** Employer identification number

Deductions and Adjustments Worksheet

Note: *Use this worksheet only if you plan to itemize deductions or claim adjustments to income on your 1990 tax return.*

1 Enter an estimate of your 1990 itemized deductions. These include: qualifying home mortgage interest, 10% of personal interest, charitable contributions, state and local taxes (but not sales taxes), medical expenses in excess of 7.5% of your income, and miscellaneous deductions (most miscellaneous deductions are now deductible only in excess of 2% of your income) . . . 1 $______

2 Enter: { $5,450 if married filing jointly or qualifying widow(er) / $4,750 if head of household / $3,250 if single / $2,725 if married filing separately } . . . 2 $______

3 **Subtract** line 2 from line 1. If line 2 is greater than line 1, enter zero . . . 3 $______

4 Enter an estimate of your 1990 adjustments to income. These include alimony paid and deductible IRA contributions . . . 4 $______

5 **Add** lines 3 and 4 and enter the total . . . 5 $______

6 Enter an estimate of your 1990 nonwage income (such as dividends or interest income) . . . 6 $______

7 **Subtract** line 6 from line 5. Enter the result, but not less than zero . . . 7 $______

8 **Divide** the amount on line 7 by $2,000 and enter the result here. Drop any fraction . . . 8 ______

9 Enter the number from Personal Allowances Worksheet, line G, on page 1 . . . 9 ______

10 **Add** lines 8 and 9 and enter the total here. If you plan to use the Two-Earner/Two-Job Worksheet, also enter the total on line 1, below. Otherwise, **stop here** and enter this total on Form W-4, line 4 on page 1 . . . 10

Two-Earner/Two-Job Worksheet

Note: *Use this worksheet only if the instructions at line G on page 1 direct you here.*

1 Enter the number from line G on page 1 (or from line 10 above if you used the Deductions and Adjustments Worksheet) . . . 1 ______

2 Find the number in **Table 1** below that applies to the **LOWEST** paying job and enter it here . . . 2 ______

3 If line 1 is **GREATER THAN OR EQUAL TO** line 2, subtract line 2 from line 1. Enter the result here (if zero, enter "0") and on Form W-4, line 4, on page 1. **DO NOT** use the rest of this worksheet . . . 3 ______

Note: *If line 1 is* ***LESS THAN*** *line 2, enter "0" on Form W-4, line 4, on page 1. Complete lines 4–9 to calculate the additional* ***dollar*** *withholding necessary to avoid a year-end tax bill.*

4 Enter the number from line 2 of this worksheet . . . 4 ______

5 Enter the number from line 1 of this worksheet . . . 5 ______

6 **Subtract** line 5 from line 4 . . . 6 ______

7 Find the amount in **Table 2** below that applies to the **HIGHEST** paying job and enter it here . . . 7 $______

8 **Multiply** line 7 by line 6 and enter the result here. This is the additional annual withholding amount needed 8 $______

9 Divide line 8 by the number of pay periods each year. (For example, divide by 26 if you are paid every other week.) Enter the result here and on Form W-4, line 5, page 1. This is the additional amount to be withheld from each paycheck . . . 9 $

Table 1: Two-Earner/Two-Job Worksheet

Married Filing Jointly		**All Others**	
If wages from **LOWEST** paying job are—	Enter on line 2 above	If wages from **LOWEST** paying job are—	Enter on line 2 above
0 - $4,000	0	0 - $4,000	0
4,001 - 8,000	1	4,001 - 8,000	1
8,001 - 19,000	2	8,001 - 14,000	2
19,001 - 23,000	3	14,001 - 16,000	3
23,001 - 25,000	4	16,001 - 21,000	4
25,001 - 27,000	5	21,001 and over	5
27,001 - 29,000	6		
29,001 - 35,000	7		
35,001 - 41,000	8		
41,001 - 46,000	9		
46,001 and over	10		

Table 2: Two-Earner/Two-Job Worksheet

Married Filing Jointly		**All Others**	
If wages from **HIGHEST** paying job are—	Enter on line 7 above	If wages from **HIGHEST** paying job are—	Enter on line 7 above
0 - $44,000	$310	0 - $25,000	$310
44,001 - 90,000	570	25,001 - 52,000	570
90,001 and over	680	52,001 and over	680

Privacy Act and Paperwork Reduction Act Notice.—We ask for this information to carry out the Internal Revenue laws of the United States. We may give the information to the Department of Justice for civil or criminal litigation and to cities, states, and the District of Columbia for use in administering their tax laws. You are required to give this information to your employer.

The time needed to complete this form will vary depending on individual circumstances. The estimated average time is: **Recordkeeping 46** min., **Learning about the law or the form** 10 min., **Preparing the form** 70 min. If you have comments concerning the accuracy of these time estimates or suggestions for making this form more simple, we would be happy to hear from you. You can write to the **Internal Revenue Service,** Washington, DC 20224, Attn: IRS Reports Clearance Officer, T:FP; or the **Office of Management and Budget,** Paperwork Reduction Project (1545-0010), Washington, DC 20503.

★U.S.GPO 1989-0-245-064

TAX TABLE

MARRIED Persons–**WEEKLY** Payroll Period

(For Wages Paid After December 1989)

And the wages are–		And the number of withholding allowances claimed is–										
At least	But less than	0	1	2	3	4	5	6	7	8	9	10
$0	$70	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
70	75	1	0	0	0	0	0	0	0	0	0	0
75	80	2	0	0	0	0	0	0	0	0	0	0
80	85	3	0	0	0	0	0	0	0	0	0	0
85	90	3	0	0	0	0	0	0	0	0	0	0
90	95	4	0	0	0	0	0	0	0	0	0	0
95	100	5	0	0	0	0	0	0	0	0	0	0
100	105	6	0	0	0	0	0	0	0	0	0	0
105	110	6	0	0	0	0	0	0	0	0	0	0
110	115	7	1	0	0	0	0	0	0	0	0	0
115	120	8	2	0	0	0	0	0	0	0	0	0
120	125	9	3	0	0	0	0	0	0	0	0	0
125	130	9	3	0	0	0	0	0	0	0	0	0
130	135	10	4	0	0	0	0	0	0	0	0	0
135	140	11	5	0	0	0	0	0	0	0	0	0
140	145	12	6	0	0	0	0	0	0	0	0	0
145	150	12	6	0	0	0	0	0	0	0	0	0
150	155	13	7	1	0	0	0	0	0	0	0	0
155	160	14	8	2	0	0	0	0	0	0	0	0
160	165	15	9	3	0	0	0	0	0	0	0	0
165	170	15	9	3	0	0	0	0	0	0	0	0
170	175	16	10	4	0	0	0	0	0	0	0	0
175	180	17	11	5	0	0	0	0	0	0	0	0
180	185	18	12	6	0	0	0	0	0	0	0	0
185	190	18	12	6	1	0	0	0	0	0	0	0
190	195	19	13	7	1	0	0	0	0	0	0	0
195	200	20	14	8	2	0	0	0	0	0	0	0
200	210	21	15	9	3	0	0	0	0	0	0	0
210	220	22	17	11	5	0	0	0	0	0	0	0
220	230	24	18	12	6	0	0	0	0	0	0	0
230	240	25	20	14	8	2	0	0	0	0	0	0
240	250	27	21	15	9	3	0	0	0	0	0	0
250	260	28	23	17	11	5	0	0	0	0	0	0
260	270	30	24	18	12	6	0	0	0	0	0	0
			26		14	8	2	0	0	0	0	0

ASSIGNMENT SHEET 1	MANAGING THE BUSINESS	XV

NAME ______________________________ SCORE _______

OBJECTIVE 16 **Calculate an employee's paycheck.**

INTRODUCTION Every greenhouse manager should know how to calculate employee payroll. It is a simple task that is easy to do. Professional accountants will also calculate paychecks for your business for a monthly fee.

DIRECTIONS Figure the net pay for Jan Doe using the time card on the following page and the tax chart in Supplement 3. Make sure all taxes are calculated and the net pay determined.

Jan is married and has claimed three withholding allowances on her W-4; she is paid weekly. FICA is 7.65% and state tax should be calculated at 6%. Jan's hourly wage is $6.50.

Name Jan Doe

Pay Period Jan. 18-24, 19..

Date	Day of Week	In	Out	Lunch	Total Hrs. Worked
1/18	Su				
1/19	M	8	5	1.0	
1/20	T	8	4:30	0.5	
1/21	W				
1/22	TH	1	5	-0-	
1/23	F	9	6	.75	
1/24	SA	7	4	1.0	

Total hours/week______

OFFICE USE ONLY		
Total Hrs.	Rate of Pay	Withholdings
Gross Salary		
FICA		
Federal Tax		
State Tax		
Total Deductions		
Net Pay		

1. How many hours did Jan work during the pay period? ____
2. What is her gross salary? ____________________________
3. How much FICA should be withheld from her check? ____
4. How much Federal tax should be withheld? ____________
5. How much State tax should be withheld? ______________
6. What is the net amount of Jan's paycheck? ___________

ASSIGNMENT SHEET 2

MANAGING THE BUSINESS

XV

NAME ______________________ SCORE ________

OBJECTIVE 17 **Prepare a production budget.**

INTRODUCTION Objectives 3 and 5 discuss the importance of estimating cost when operating a greenhouse. A greenhouse manager must make sure adequate cash is available for buying supplies and producing the crop. The activity on this assignment sheet emphasizes this area.

DIRECTIONS Use the A. H. Hummert's catalog to prepare a budget for producing 1600 4" azalea pot cutting geraniums. Geranium cuttings cost $35.00 per 100 cuttings and freight is 15% of the plant cost.

Fill in the itemized budget below and determine the total estimated budget for producing the geranium crop.

Budgeted item — Estimated cost

Pots (Kord 4" azalea) ____________

Media (Pro-Mix Bx) ____________

Cuttings ____________

Freight on cuttings ____________

1 quart Subdue ____________

1 bag of Peter's 20-10-20 peat lite ____________

1 quart Cycocel ____________

Total budget ____________

ASSIGNMENT ANSWERS

MANAGING THE BUSINESS XV

ASSIGNMENT SHEET 1

Use the following criteria for evaluation.

1. 36.25
2. $235.63
3. $18.03
4. $8.00
5. $14.14
6. $195.46

ASSIGNMENT SHEET 2

Pots	$ 36.30 (4 cases)	$145.20
Media	$ 23.25 (3 bales)	$ 69.75
Cuttings	$ 35.00 (16 trays)	$560.00
Shipping	$ 84.00	
1 qt. Subdue	$ 52.90	
1 bag Peter's	$ 22.15	
1 qt. Cycocel	$ 46.95	
TOTAL BUDGET	$980.95	

WRITTEN TEST

MANAGING THE BUSINESS

XV

NAME ______________________________ SCORE _______

OBJECTIVE 1

Select from a list true statements about accounting systems. Write an "X" in the blank before each true statement.

____ 1. Most greenhouse managers have had enough accounting classes that they will not profit from the help of a professional accountant.

____ 2. Professional accountants know how to use financial information while the small business person may not.

____ 3. A record keeping system purchased at an office supply or stationery store should never be used by a greenhouse manager.

____ 4. A professional accountant will save your business time, money and problems in the long run.

____ 5. The accounting system a business chooses must be easy to use and reliable.

____ 6. Keeping clear and precise records is very important to a successful business.

OBJECTIVE 2

Select from a list true statements about establishing business policies. Write an "X" in the blank before each true statement.

____ 1. The greenhouse management should predetermine policies to be used in collecting money from charge customers.

____ 2. Treat each charge customer as an individual and use special rules for some.

____ 3. Customers should be made aware of return policies of the greenhouse.

____ 4. The customer should be informed about guarantees at the time of the sale.

____ 5. Plan to make loan payments during slow months so you will have time to make out the checks.

____ 6. Most suppliers are anxious to help a new greenhouse become established.

OBJECTIVE 3

Discuss the use of budgets in the greenhouse business. Answer the following questions in the space provided.

1. What is a budget? ______________________________

____

____

____

2. Can budgets be strictly followed? ________________

____

3. Name three different budgets a greenhouse should prepare.

____

____

____

4. Why should budgets be checked monthly? __________

____

____

____

____

OBJECTIVE 4

Complete statements about presenting a credit plan. Fill in the blanks with the correct word.

1. A credit plan is your projected operation plan and estimated income for the business. It shows the lender how your business will be able to pay off ________________.
2. A person wanting to buy a greenhouse must choose a lawyer and an ____________ before meeting with a banker.
3. Bankers do not like to see credit plans that ____________ the amount of money needed to buy a business.
4. Lenders like to see a person seeking a loan to purchase a business to personally invest ____________ percent of the loan amount in cash.
5. Credit plans should be neatly prepared and as ____________ as possible.

OBJECTIVE 5

Select from a list true statements about calculating cash flow. Write an "X" in the blank before each true statement.

____ 1. Cash flow is the amount of money a business earns during the fiscal year.

____ 2. Successful businesses require a negative cash flow to operate.

____ 3. Estimated cash flow statements should be prepared 3-6 months ahead.

____ 4. Reserve cash must carry a greenhouse through periods of negative cash flow.

____ 5. Negative cash flow can only be corrected by increasing sales.

OBJECTIVE 6

Match parts of a financial statement to their descriptions. Write the correct letter in the blanks.

____ 1. Shows the profit or loss for a specific period of time

____ 2. Shows the current balance of each asset and liability account

____ 3. Details the amount of money the owner has invested in the business

a. Revenue statement

b. Income statement

c. Statement of owner's equity

d. Estimated cash flow

e. Balance sheet

OBJECTIVE 7

Select from a list true statements about completing a loan application. Write an "X" in the blank before each true statement.

____ 1. Loan applications are much like any other form; they must be completed properly.

____ 2. An accountant will usually be required to calculate many of the figures requested.

____ 3. A loan application should be submitted at least one week ahead of the other required financial statements.

____ 4. A loan applicant should be prepared to defend the proposed financial plans when they meet with the lender.

____ 5. Many parts of the application will not apply to greenhouse businesses and should be left blank.

____ 6. Accurately and truthfully complete the form.

OBJECTIVE 8

Discuss tax requirements as they apply to greenhouse businesses. Answer the following questions in the space provided.

1. What type of tax must a greenhouse collect from its customers?

2. What taxes must be withheld from employee paychecks?

3. Which tax requires employers to match the amount withheld from employee payroll?

4. Who pays unemployment insurance and worker's compensation, the employee or the employer?

5. Why is a certified public accountant useful when filing taxes?

OBJECTIVE 9

Calculate net worth.

Fred Smith needs his net worth for the loan application he is completing. Using the list of assets and liabilities below, what is Fred's net worth?__________________

Assets		Liabilities	
Pickup truck	$ 2,800	House loan	$ 91,450
Saving account	$ 6,482	Medical bills	$ 1,660
House	$ 94,500	Truck loan	$ 1,750
Life insurance	$ 14,000	Car loan	$ 8,539
Stocks	$ 16,500		
Farm machinery	$ 3,400		
Car	$ 9,000		
Personal property	$ 7,250		

OBJECTIVE 10

Complete statements about employee work schedules. Write the missing word in each blank.

1. Employees are one of the best _____________ of a successful business.
2. Employee work schedules should be planned at least _____________ weeks in advance.
3. Try to prepare work schedules so _____________ employees work together.
4. A work schedule should reflect the number of employees needed for the _____________.
5. Assigning the correct employee to each task increases _____________ and profits.

OBJECTIVE 11

List guidelines for employee training programs. Write five guidelines in the space provided.

OBJECTIVE 12

Discuss employee evaluation procedures. Answer the following questions in the space provided.

1. Why should all employees be periodically evaluated?

2. How is the proper way to conduct an employee evaluation?

3. Name five areas in which greenhouse employees are usually evaluated.

4. Name three ways a greenhouse manager can reward good employees.

5. Why is constructive criticism so important in employee evaluations?

OBJECTIVE 13

Identify characteristics of a good supervisor. Write an "X" in the blank before each characteristic of a good supervisor.

____ 1. Ability to motivate employees to perform to the best of their ability

____ 2. College degree in business management

____ 3. Ability to deal with many personalities

____ 4. Personal interest in each employee

____ 5. Ability to treat each employee with respect

____ 6. Ability to listen to complaints or comments of employees.

____ 7. Ability to project the attitude that "I'm the boss and employees better listen to me."

OBJECTIVE 14

Discuss factors involved in calculating payroll. Answer the following questions in the space provided.

1. Why must all employees fill out a W-4 form?

2. What is the current rate of social security withholding?

3. What should an employer do with the money that is withheld from employee paychecks?

OBJECTIVE 15 **Discuss computer use in the greenhouse industry.** Answer the following questions in the space provided.

1. Name four tasks a computer can be used for in the greenhouse or greenhouse office.

   ____

   ____

   ____

   ____

2. Why must a greenhouse manager know his or her needs before shopping for computer hardware or software?

   ____

   ____

   ____

3. Why should a person visit other greenhouse managers who have computer systems before buying a computer for their business?

   ____

   ____

   ____

4. What are the two major questions you should ask a computer salesperson when looking at their brand of hardware or software?

   ____

   ____

   ____

NOTICE The following assignment sheets are not part of the written test. If these activities have not been completed, check with your instructor.

OBJECTIVE 16 **Calculate an employee's paycheck.** SCORE ________

OBJECTIVE 17 **Prepare a production budget.** SCORE ________

WRITTEN TEST ANSWERS	MANAGING THE BUSINESS XV
OBJECTIVE 1	2, 4, 5, 6
OBJECTIVE 2	1, 3, 4, 6
OBJECTIVE 3	1. Estimated plan of what it will cost to complete a task. 2. No 3. Answer should include any three of the following: – Advertising – Sales – Labor – Operating expenses 4. To compare actual expenses to what was budgeted and see if you are over spending.
OBJECTIVE 4	1. Creditors 2. Accountant 3. Underestimate 4. 20-25% 5. Accurate
OBJECTIVE 5	3, 4
OBJECTIVE 6	1. b 2. e 3. c
OBJECTIVE 7	1, 2, 4, 6

OBJECTIVE 8

1. Sales tax
2. FICA, federal income tax, state income tax
3. FICA
4. Employer
5. They are familiar with the required tax forms and the filing deadlines. They will save the greenhouse money by not having to pay penalties for late filing or improperly completed forms.

OBJECTIVE 9

$50,533

OBJECTIVE 10

1. Assets
2. Two
3. Compatible
4. Task or job
5. Productivity

OBJECTIVE 11

Answers should include any five of the following:

- Assign new employees to work with established employees.
- Inform new employees of the reasons behind procedures.
- Limit the number of jobs for which a new employee is trained to two a day.
- Train new employees on simple tasks first and more complicated tasks later.
- Present new employees with a policies and procedures manual.
- Monitor new employees closely as they learn new tasks.
- Train new employees during calm periods.
- Create an atmosphere where employees may ask questions and make suggestions.
- Do not expect all employees to be trained at the same rate.

OBJECTIVE 12

1. So they know how they are doing and if they can improve.
2. Sit down alone with the employee and discuss the employee's performance.
3. Answer should include any five of the following:
   - Courteousness
   - Promptness
   - Physical appearance
   - Sales skills
   - Knowledge of plant materials
   - Transplanting skills
4. Answer should include any three of the following:
   - Tickets to movies
   - Gift certificates for restaurants
   - Picnics
   - Salary increases
5. Negative criticism will not motivate or encourage employees to do a better job.

OBJECTIVE 13

1, 3, 4, 5, 6

OBJECTIVE 14

1. To inform employers how many tax deductions an employee has.
2. 7.65 percent
3. Deposit it into a special checking account used for paying employment taxes.

OBJECTIVE 15

1. Answer should include any four of the following:

- Control the temperature
- Control the humidity
- Control the light intensity
- Sense the need for mist in the progagation house
- Water potted crops
- Calculate growing schedules and space requirements for crop production
- Keep track of inventory
- Determine sale prices
- Accounting procedures
- Mailing lists
- Newsletters
- Calculate payroll

2. So the hardware or software purchased will be able to do what you want it to.

3. To talk with them and see what they recommend, what they like and what they don't like. They can tell you what mistakes they made with their computer and prevent you from making the same mistakes.

4. What kind of technical service do they offer after the purchase?

   Can the system be upgraded or expanded easily in the future?

OBJECTIVE 16 Refer to answers to Assignment Sheet 1.

OBJECTIVE 17 Refer to answers to Assignment Sheet 2.

OBJECTIVE SHEET

APPLYING SAFETY REGULATIONS

XVI

INTRODUCTION

Accidents can occur at any time and may cause life long disabilities. By using safety procedures and providing the safest possible working environment, accidents can be prevented and the safety of personnel guaranteed.

UNIT OBJECTIVE

After completing this unit, the student should be familiar with required safety regulations and safety procedures that reduce the chances of injury. The student will demonstrate these competencies by completing an assignment sheet and written test with a minimum of 100 percent accuracy.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. List factors to look for when conducting safety inspections.
2. Discuss federal regulations concerning greenhouse operation.
3. Discuss safety regulations for working near automated equipment.
4. Select from a list true statements about conducting safety training programs.
5. Match the basic classes of fires with examples of each class.
6. List guidelines for using fire extinguishers.
7. Complete safety test. (Assignment Sheet 1)

SUGGESTED ACTIVITIES

APPLYING SAFETY REGULATIONS XVI

PREPARATION

- Obtain materials to supplement unit.

  NOTE: See Suggested Resources.

- Review instructional outline for this unit. Modify time frames to suit class needs and plan activities for each class period.
- Study the specific objectives to determine those you will cover in your presentation. Decide also which objectives should be taught to which students.
- Determine scope and sequence of objectives that you add. Design and develop support materials, including evaluation techniques, for additional objectives.
- Determine how you will schedule time for students to demonstrate competence in the required procedures.
- Make arrangements for guest speakers. Supply speakers with specific objectives and other appropriate sections of the unit.

DELIVERY

Objective 1

- Discuss conducting safety inspections in greenhouses.
- Tour your greenhouse with students and inspect for possible safety hazards. Have students suggest correction measures.

Objectives 2 and 3

- Discuss federal regulations concerning greenhouse operations. Discuss with students the importance of complying with federal regulations that deal with greenhouse worker protection.
- Show the video *Material Safety Data Sheet/Chemical Safety.*
- Discuss safety regulations for working near automated equipment.
- Invite the shop teacher to discuss safety rules with students.

Objective 4

- Discuss conducting safety training programs. Ask students if they have ever been involved in safety training programs.
- Have students discuss how they would implement a safety training program.

Objectives 5 and 6

- Discuss using the correct fire extinguisher. Use Transparency Masters 1 and 2.
- Invite a local firefighter to discuss fire extinguishers and the correct way to use them.
- Show the video *Safety on the Job: Fire Extinguishers.*

APPLICATION

Objective 7

- Use Assignment Sheet 1 to teach students correct safety rules.

EVALUATION

Written Test

- Explain to students that they will be asked to demonstrate on the written test actions listed in the specific objectives.
- Give written test

  NOTE: Written test may be given in sections if desired.
- Evaluate students on assignment sheet activity if not previously done.
- Reteach and retest if necessary.
- Complete appropriate section of competency profiles.
- Review individual and group performance in order to evaluate teaching methods. Adjust scope, sequence, or instructional approaches for additional lessons as required.

SUGGESTED RESOURCES

Audiovisual Materials

- *Material Safety Data Sheet/ Chemical Safety.* 1/2" VHS, color, 25 min., 1986, TPC Training Systems - Tech. Publ. Available from TPC Training Systems, 1301 S. Grove Ave., P.O. Box 1030, Barrington, IL 60010, 312-381-1840. A puppet explains the MSDS sheets. He goes over different definitions, hazards, and how to read the MSDS sheets. At the end of this video are 10 questions and answers that cover the information from the video.

- *Safety on the Job: Fire Extinguishers.* 1/2" VHS, color, 23 min., 1988, Aims Instructional Media. Available from Aims Instructional Media, 6901 Woodley Ave., Van Nys, CA 91406, 800-367-2467. When a fire starts, it is critical to know what type of fire extinguisher will put it out. Every fire is not the same. Viewers learn about the four different types of fires and fire extinguishers and the five main types of extinguishing agents. They also learn what to do in a fire emergency before using a fire extinguisher.

NOTE: The above videos are available to Oklahoma teachers on a free-loan basis. Oklahoma teachers may order these videos from the Oklahoma Department of Vocational and Technical Education, Resource Center, ATTN: Instructional Media Specialist, 1500 West Seventh Avenue, Stillwater, OK 74074, 1-800-522-5810. Out-of-state teachers must order from the addresses listed with each video.

UNIT REFERENCES

- *Agricultural Mechanics*, Curriculum and Instructional Materials Center, Oklahoma Department of Vocational and Technical Education, Stillwater, Oklahoma.

- *Code of Federal Regulations*, Office of the Federal Register National Archives and Records Administration, Washington, DC, 1989.

BASIC ACADEMIC SKILLS

The following table identifies the basic academic skills that are reinforced in this unit of instruction. These basic academic skills were identified using *The Basic/Essential Skills Taxonomy*, 2nd edition, and verified during the validation process.

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 1	Language Arts 132	Comprehends	Information-written	
	Language Arts 038	Collects/ Organizes	Information-oral/written	
OBJECTIVE 2	Language Arts 092	Composes/ Edits	Reports/ essays	Information supplying
	Free Enterprise 092	Describes/ Explains	Government impact/costs	Regulations
OBJECTIVE 3	Language Arts 038	Collects/ Organizes	Information-oral/written	
	Language Arts 098	Composes/ Edits	Reports/ essays	Summaries
OBJECTIVE 4	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity
OBJECTIVE 5	Language Arts 013	Applies/Uses	Definitions	
	Science 466	Identifies	Definitions	

	SKILL AREA/ CODE	VERB	LINK A	LINK B
OBJECTIVE 6	Language Arts 132	Comprehends	Information-written	
	Language Arts 038	Collects/ Organizes	Information-oral/written	
OBJECTIVE 7	Language Arts 139	Comprehends	Information-written	Context
	Language Arts 191	Evaluates	Information-written	Validity

OBJECTIVE 1 **List factors to look for when conducting safety inspections.**

Routine safety inspections of the greenhouse are necessary to detect safety violations and to allow the greenhouse manager to quickly correct the problems. Walk through the greenhouse, headhouse, chemical storage area and work area and look for unsafe situations. The following are some of the situations to look for:

- Hoses scattered in the greenhouse aisles
- Pieces of metal or wire sticking from greenhouse benches
- Unprotected fan blades, motors, pulleys, etc.
- Low hanging trusses, support beams, wires, hanging baskets
- Unstable flooring; cracked concrete, loose gravel, slick mud or algae
- Exposed wiring or improperly wired electrical equipment
- Faulty, broken or improperly stored tools
- Improperly trained employees or employees who are using equipment they do not know how to operate
- Employees incorrectly dressed for the job
- Horseplay or poor work attitude by employees
- Chemicals left out of the storage area
- Improper application of chemicals
- Leaking chemical containers
- Improper reentry periods

OBJECTIVE 2

Discuss federal regulations concerning greenhouse operation.

The federal government has issued specific safety regulations that must be followed by all greenhouse operators. The federal government also allows state governments the power to enforce federal rules.

- Rules regarding safety requirements are constantly changing and a grower must keep informed of all changes.
  - Growers' associations and trade magazines are good sources of information on safety regulations.
- Disposal and storage regulations require that all chemicals be stored in closed containers that are clearly labeled.
  - Storage facilities must be labeled outside with a sign informing people that chemicals or pesticides are stored within the area.
  - Disposal laws state that local fire departments should be given a list of all chemicals kept in the chemical storage area.
- Worker's protection standards require that a chemical applicator's license is required to purchase restricted use chemicals.
  - This regulation states that any nonlicensed greenhouse worker applying chemicals must be supervised by a licensed applicator.
  - Applicators must be able to read and comprehend the information contained on a chemical label.
- Hazardous communication standard requires that all greenhouse employees be made aware of the hazards of materials used at a greenhouse.
  - Employees must receive information and training on the chemicals they are using. They must be made aware of the physical hazards of the chemical and how to detect the presence of the chemicals.
  - Employees must be made aware of protective procedures they must use to prevent bodily injury. These training programs must teach employees how to safely mix and apply chemicals.

  - A training program should include a written test. This proves the employee can read, and is capable of understanding chemical labels.

  - Material Safety Data Sheets (MSDS) for every chemical used at the greenhouse must be available for employee inspection. Material Safety Data Sheets list all information about the chemical. They give information about its toxicity, crops it can be used on, reentry periods and the actual chemical composition of the material.

  - These sheets can be kept in one central location for an entire greenhouse range.

  - Chemical suppliers are required to supply MSDS sheets to greenhouses whenever a chemical is purchased. The local fire protection organization should receive a copy of all MSDS from the greenhouse.

- Hazardous chemical reporting regulation gives a local community the right to know what chemicals a greenhouse uses and stores.

  - This regulation states that a greenhouse has to report to the state agency all hazardous chemicals that are kept at the business. The agency is either the Emergency Planning Committee (EPC) or the local fire chief.

  - MSDS supplied to the EPC or fire chief to fulfill this requirement.

  - This regulation also allows the fire chief or EPC to conduct an on-site inspection of chemical storage facilities.

  - The general public can receive copies of the greenhouses' MSDS by sending a written request to the EPC or fire chief.

- Keep in mind that many of these rules will not be routinely enforced. However, if there is a chemical accident or complaint about your greenhouse the regulations will be enforced and citations will be issued for failure to comply.

OBJECTIVE 3

Discuss safety regulations for working near automated equipment.

Automated equipment is powered by electrical or gasoline motors. These motors are very powerful and operate at high rates of speed. Employees must be aware of the potential for injury when working near this type of equipment.

- All factory installed safety devices must remain on the equipment. These devices were designed and installed to prevent injury and should not be removed.
  - Warranties and manufacturer liability is voided if the owner or operator alters or removes safety devices.
- Long hair should be held under a hat or hairnet to prevent it from becoming caught in equipment.
- No jewelry should be worn while working near automated equipment. A ring, watch or necklace could easily become caught in the moving parts of the equipment.
- Loose, baggy clothes can also get caught in the moving parts.
  - Closed toe shoes and long pants should also be worn. This clothing gives the body more protection in case of an accident.
- Safety goggles must be worn when working near or with any type of power equipment. A rapidly moving machine can easily toss out small fragments which could become embedded in the employee's eye.
- Use ear protection near equipment that makes noise. Small foam plugs are inexpensive but efficient.
- Train employees how to properly use automated equipment.
- Accidents occur when employees who do not know how to properly use equipment try to operate it. Also, they may have learned incorrectly and have been lucky that an accident has not occurred.
- Use the buddy system when working with automated equipment. If an accident should occur someone will be there to aid the victim and get emergency help.

OBJECTIVE 4

Select from a list true statements about conducting safety training programs. All employees and supervisors need to be constantly refreshed on safety training. The best way to reduce accidents is to have trained, safety conscious employees. However, when accidents do occur make sure that greenhouse personnel are prepared to handle the situation.

- Many greenhouses hold monthly safety meetings.
  - Employees are encouraged to discuss any safety concerns they may have. They usually have great ideas on how to improve a problem.
  - Rewards are given to employees when the business has been injury or accident free for the period.

    EXAMPLES: Popcorn and soft drinks for an accident free month; catered barbecue lunch for six months without accidents
  - Discussing and promoting safety keeps employees thinking about safety.
- A short class should be given every month to teach employees how to properly and safely complete tasks or handle an emergency situation.
  - Have several employees conduct the class; teach them how to do the task and let them teach their co-workers.
  - Invite guest speakers to talk to your employees.

    EXAMPLE: A firefighter could demonstrate the correct way to use a fire extinguisher.
- A basic first-aid class should be mandatory for all employees.
- Train all personnel to quickly notify emergency personnel, fire department, paramedics and/or police.
  - Important emergency phone numbers should be posted by all telephones.
- Send employees to safety training classes offered by local organizations or universities. The employees who attend the class can teach the rest of the employees when they return to the job.

- Use signs and posters to remind employees how to properly do a job.
  - Signs should be simple, colorful and to the point. Pictures transfer the desired effect better than words.
- Clearly post areas that are dangerous; chemical storage facilities must have a sign on the outside, paint the floor yellow where a hazard exists overhead or where tripping or stumbling may occur.
  - Label emergency aid stations. A red cross should be posted above first-aid kits. This lets employees quickly locate the aid station in an emergency.
  - Emergency shut off levers, switches and buttons should be painted red. Fire extinguishers and their storage area should also be red.

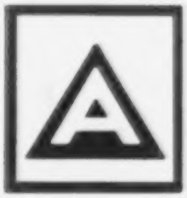
OBJECTIVE 5

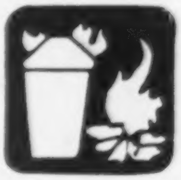
Match the basic classes of fires with examples of each class. (Transparency Masters 1 and 2)

A fire can start anywhere in the greenhouse; greenhouse coverings are highly flammable, electrical equipment can ignite due to faulty wiring, or chemicals can ignite due to heat or improper storage. Regardless of how a fire starts, the proper type of fire extinguisher must be used. Fire extinguishers will have a label across the front showing which class(es) of fire they may be used on.

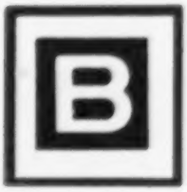
Fires are divided into classes depending on the type of material burning.

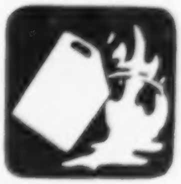
- Class A—Ordinary combustible materials such as paper, wood, and cloth



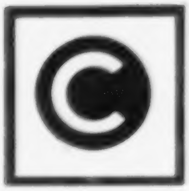


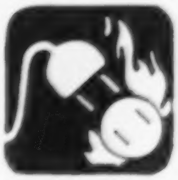
- Class B—Flammable liquids such as grease, gasoline, oils, and paints



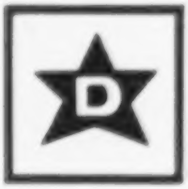


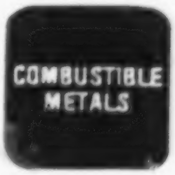
- Class C—Electrical equipment such as motors, switches, and computers





- Class D—Combustible metals such as zinc, magnesium, and potassium



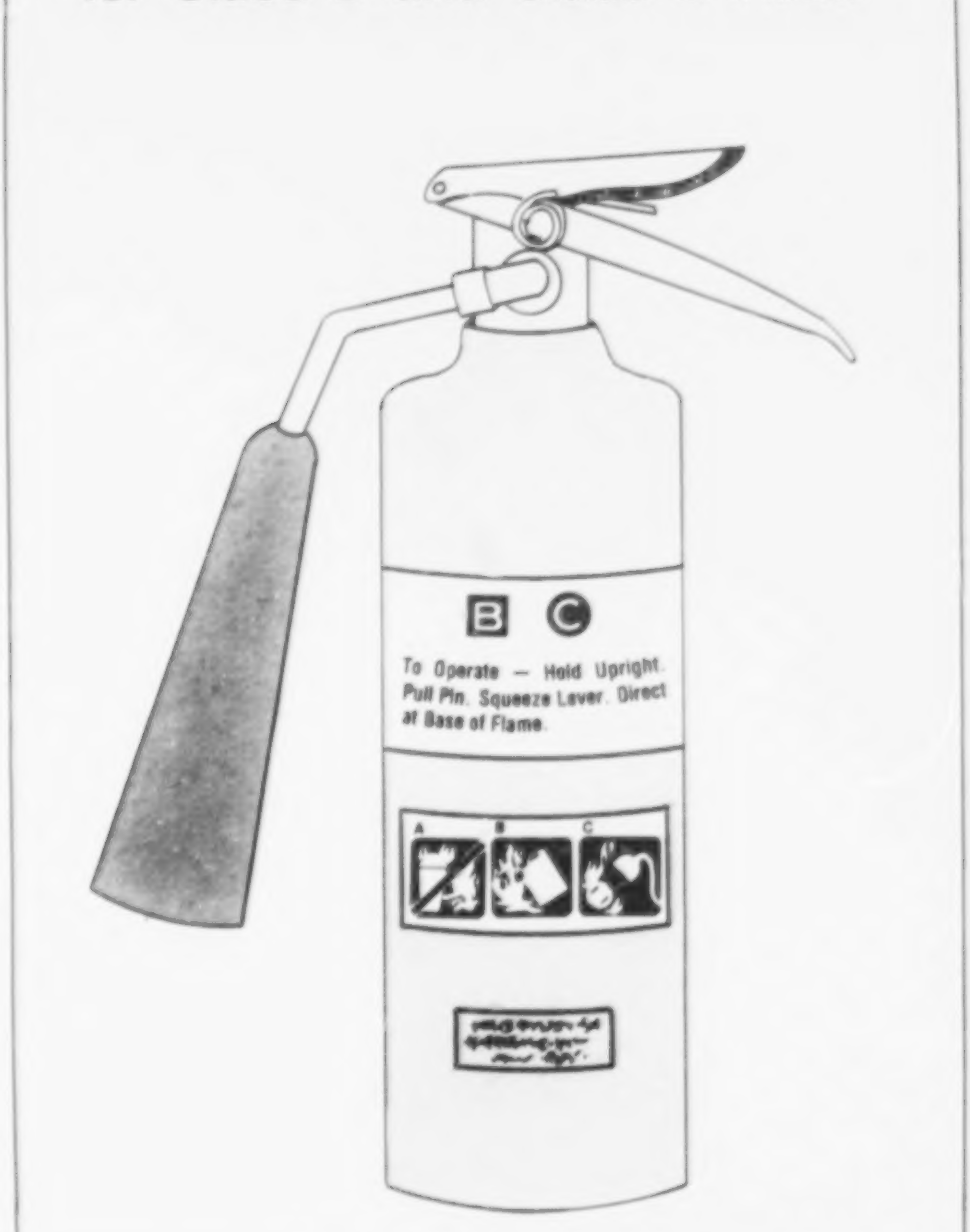


OBJECTIVE 6 **List guidelines for using fire extinguishers.**

- Each greenhouse should contain a fire extinguisher. Extinguishers should also be located in the headhouse and any other work area.
- When purchasing an extinguisher select one that is adapted to its intended location.

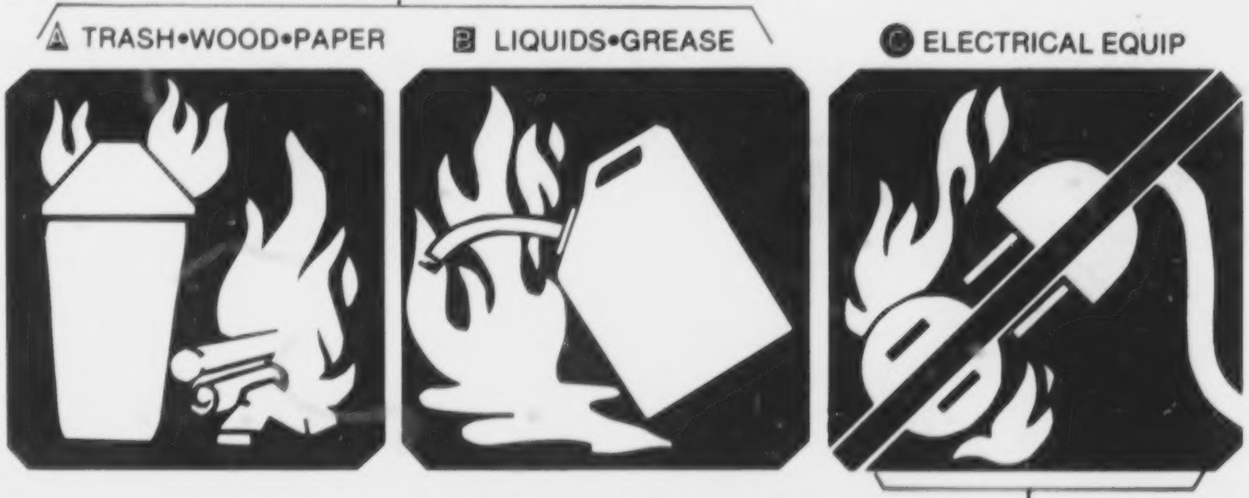
  NOTE: Newer extinguishers are made to be used on several types of fires. There is a list of the types of fires they will control on the extinguisher.
- Make sure employees know where extinguishers are located and how to properly use them.
- Periodically inspect all extinguishers to make sure they are holding their charge and are usable.

Fire Extinguisher Suitable for Class B and Class C Fires


B C
To Operate — Hold Upright. Pull Pin. Squeeze Lever. Direct at Base of Flame.
A
B
C

New Pictorial Symbols Used to Label Fire Extinguishers

Symbols with blue backgrounds indicate fire extinguisher can be used for class of fire portrayed.


A TRASH•WOOD•PAPER
B LIQUIDS•GREASE
C ELECTRICAL EQUIP

Symbols with red line across a black background indicate fire extinguisher *cannot* be used for class of fire portrayed.

ASSIGNMENT SHEET 1

APPLYING SAFETY REGULATIONS

XVI

NAME ______________________________ SCORE _______

OBJECTIVE 7 **Complete safety test.**

INTRODUCTION The following test uses the safety regulation information given in this unit.

DIRECTIONS Write a T in the blank before true statements.

____ 1. It is all right to let greenhouse employees play around while working; it improves their morale.

____ 2. Tools should be placed in the proper storage area at the end of each work day.

____ 3. Each greenhouse should contain a fire extinguisher.

____ 4. Jewelry should not be worn when operating automated machinery.

____ 5. Ear protection is not required when working near automated equipment.

____ 6. Signs and posters placed in the headhouse help promote safety.

____ 7. Worker's protection standards requires a person to have a license to purchase restricted use chemicals.

____ 8. Material Safety Data Sheets only have to be kept in the greenhouses that store fungicides.

ASSIGNMENT ANSWERS

APPLYING SAFETY REGULATIONS

XVI

ASSIGNMENT SHEET 1	2, 3, 4, 6, 7

WRITTEN TEST

APPLYING SAFETY REGULATIONS XVI

NAME ______________________________ SCORE ________

OBJECTIVE 1

List factors to look for when conducting safety inspections. In the space provided write four potential safety hazards to look for when inspecting a greenhouse .

OBJECTIVE 2

Discuss federal regulations concerning greenhouse operation.

1. What are the three requirements of the disposal and storage regulation?

2. What do workers' protection standard state about nonlicensed employees spraying chemicals?

3. Why should a greenhouse training program include a written test?

4. Where does a greenhouse grower obtain MSDS?

5. The hazardous chemical reporting regulation states that a greenhouse must report all stored chemicals to whom?

OBJECTIVE 3

Discuss safety regulations for working near automated equipment.

1. Why should jewelry and loose fitting clothes be prohibited when working near automated equipment?

2. How does the buddy system promote safety at the greenhouse?

OBJECTIVE 4

Select from a list true statements about conducting safety training programs. Place an "X" in the blank before each true statement.

____ 1. Rewards should be given when the business has had an accident free period.

____ 2. Training classes should be held twice a year.

____ 3. All employees should have a basic firs-aid course.

____ 4. A green cross should be posted above a first-aid kit.

____ 5. Signs promoting safety should be complex.

____ 6. Employees should be encouraged to discuss safety concerns.

____ 7. Clearly post areas that are dangerous.

____ 8. Employees should not be sent to outside safety training classes because their procedures may be different.

____ 9. Train all personnel to quickly notify emergency personnel.

___ 10. Discussing and promoting safety keeps employees thinking about safety.

OBJECTIVE 5

Match the basic classes of fires with examples of each class. Write the correct letter in the blank.

___ 1. Flammable liquids such as grease, gasoline, oils, and paints

___ 2. Combustible metals such zinc, magnesium, potassium

___ 3. Electrical equipment such as motors, switches, and computers

___ 4. Ordinary combustible materials such as paper, wood, and cloth

a. Class A

b. Class B

c. Class C

d. Class D

OBJECTIVE 6

List guidelines for using fire extinguishers. Write three guidelines in the space provided.

____

____

____

____

____

____

NOTICE

The following assignment sheet is not part of the written test. If this activity has not been completed, check with you instructor.

OBJECTIVE 7

Complete safety test. SCORE ________

WRITTEN TEST ANSWERS

APPLYING SAFETY REGULATIONS XVI

OBJECTIVE 1

Answer should include any four of the following:

- Hoses scattered in the greenhouse aisles
- Pieces of metal or wire sticking from greenhouse benches
- Unprotected fan blades, motors, pulleys, etc.
- Low hanging trusses, support beams, wires, hanging baskets
- Unstable flooring; cracked concrete, loose gravel, slick mud or algae
- Exposed wiring or improperly wired electrical equipment
- Faulty, broken or improperly stored tools
- Improperly trained employees or employees who are using equipment they do not know how to operate
- Employees incorrectly dressed for the job
- Horseplay or poor work attitude by employees
- Chemicals left out in the storage area
- Improper application of chemicals
- Leaking chemical containers
- Improper reentry periods

OBJECTIVE 2

1. — Materials must be stored in a closed container and labeled

   — Sign posted outside chemical storage area informing people of what is stored in the facility

   — Fire departments must be given a list of all chemicals stored

2. They must be supervised by a licensed applicator

3. To prove that the employee can read and is capable of understanding chemical labels

4. From their chemical suppliers
5. The emergency planning committee, if present, or the local fire chief

OBJECTIVE 3

1. They could become caught in the moving parts of the equipment.
2. If someone gets injured there is another person present to call for emergency aid and help the victim.

OBJECTIVE 4

1, 3, 6, 7, 9, 10

OBJECTIVE 5

1. b
2. d
3. c
4. a

OBJECTIVE 6

Answer should include any three of the following:

- Each greenhouse should contain a fire extinguisher. Extinguishers should also be located in the headhouse and any other work area.
- When purchasing an extinguisher select one that is adapted to its intended location.
- Make sure employees know where extinguishers are located and how to properly use them.
- Periodically inspect all extinguishers to make sure they are holding their charge and are usable.

OBJECTIVE 7

Refer to answers to Assignment Sheet 1.